THOMAS & HUTTON

TECHNICAL SPECIFICATIONS FOR

KIAWAH RIVER PLANTATION WASTEWATER TREATMENT PLANT PHASE 1

PREPARED FOR:

KIAWAH RIVER PLANTATION HOLDINGS, LP AND OCEAN BOULEVARD PROPERTIES A SOUTH CAROLINA LIMITED PARTNERSHIP

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CONTROL OF WORK

PART 1 – GENERAL

1.01 WORK PROGRESS

A. The Contractor shall furnish personnel and equipment which will be efficient, appropriate and adequately sized to secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the time stipulated in the Contract. If at any time such personnel appears to the Engineer to be inefficient, inappropriate, or insufficient for securing the quality of work required for producing the rate of progress aforesaid, he may advise the Contractor to increase the efficiency, change the character, or increase the personnel and equipment and the Contractor shall conform to such order at no additional cost to the Owner. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

1.02 PRIVATE LAND

A. The Contractor shall not enter or occupy private land outside of easements, except by permission of the adjacent property owner and Owner. A copy of the written consent shall be given to the Engineer.

1.03 WORK LOCATIONS

A. Work shall be located substantially as indicated on the drawings, but the Owner and Engineer reserve the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons.

1.04 PIPE LOCATIONS

A. Exterior pipelines will be located substantially as indicated on the Drawings, but the right is reserved to the Owner, acting through the Engineer, to make such modifications in location as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings, etc., are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

B. Small interior piping is indicated diagrammatically on the Drawings, and the exact location is to be determined in the field. Piping shall be arranged in a neat, compact, and workmanlike manner, with a minimum of crossing and interlacing, so as not to interfere with equipment or access ways, and, in general, without diagonal runs.

1.05 DIMENSION OF EXISTING STRUCTURES

A. Where the dimensions and locations of existing structures are of importance in the installation or connection of any part of the Work, the Contractor shall verify such

dimensions and locations in the field before the fabrication of any material or equipment which is dependent on the correctness of such information.

1.06 OPEN EXCAVATIONS

A. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access to private property during construction shall be removed when no longer required. If the excavation becomes a hazard, or if it excessively restricts traffic at any point the Owner may require special construction procedures such as limiting the length of open trench, prohibiting stacking excavated material in the street, and requiring that the trench shall not remain open overnight at no additional cost.

B. The Contractor shall take precautions to prevent injury to the public and employees due to open trenches. All trenches, excavated material, equipment, or other obstacles which could be dangerous to the public shall be barricaded and well lighted at all time when construction is not in progress.

1.07 DISTRIBUTION SYSTEMS AND SERVICES

A. The Contractor shall avoid interruptions to power, water, telephone, communications, cable TV, sewer, gas, or other related utility services. He shall notify the Owner and the appropriate agency well in advance of any requirement for dewatering, isolating, or relocating a section of a utility, so that necessary arrangements may be made. The contractor shall coordinate all such arrangements.

B. If it appears that utility service will be interrupted for an extended period, the Contractor shall provide temporary service lines at the Contractor's expense. Inconvenience of the users shall be kept to the minimum, consistent with existing conditions. The safety and integrity of the systems are of prime importance in scheduling work.

1.08 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

A. The Contractor shall assume full responsibility for the protection of all buildings, structures and utilities, public or private, including poles, signs, services to building utilities, gas pipes, water pipes, hydrants, sewers, drains and electric, communications, cable and telephone cables and other similar facilities, whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from injury of any kind. Any damage resulting from the Contractor's operation shall be repaired by the Contractor at his expense.

B. The Contractor shall bear full responsibility for obtaining locations of all underground structures and utilities (including existing water services, drain lines and sewers). Services to buildings shall be maintained and all costs or charges resulting from damage thereto shall be paid by the Contractor.

C. Protection and temporary removal and replacement of existing utilities and structures as described in this Section shall be a part of the work under the Contract and all costs in connection therewith shall be included in the price established in the Bid.

D. If permanent relocation of a utility is required and is shown on the drawings, it shall be included in the contractor's base bid. The Contractor will notify the utility to perform the work as expeditiously as possible. The Contractor shall notify public utility companies in writing at least 48 hours (excluding Saturdays, Sunday and legal holidays) before excavating near their utilities.

1.09 TEST PITS

A. Contractor shall explore by test pits (or other means) for the purpose of locating and confirming underground pipeline or structures in advance of the construction shall be excavated and backfilled by the Contractor. Test pits shall be backfilled immediately after the utility location and the surface shall be restored in a manner equal or better than the original condition. No separate payment will be made. Report in writing finding to Engineer and Owner.

1.10 CARE AND PROTECTION OF PROPERTY

A. The Contractor shall be responsible for the preservation of all public and private property and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition equal or better to existing before the damage was done, or he shall make good the damage in another manner acceptable to the Owner.

B. All sidewalks and paved areas which are disturbed by the Contractor's operations shall be restored to their original or better condition by the use of similar or comparable materials. All curbing shall be restored in a condition equal to the original construction and in accordance with the best modern practice.

C. Along the location of this work, all fences, walks, bushes, trees, shrubbery, and other physical features shall be protected and restored in a thoroughly workmanlike manner unless otherwise shown on the drawings. Fences and other features removed by the Contractor shall be replaced in the same location. All grass areas beyond the limits of construction which have been damaged by the Contractor shall be regarded and sodded to equal or exceed original conditions.

D. Trees close to the work which drawings do not specify to be removed shall be fenced or otherwise protected against injury. The Contractor shall trim all branches that are liable to damage because of his operations, but in no case shall any tree be cut or removed without prior notification to the Engineer. All injuries to bark, trunk, limbs, and roots of trees shall be repaired by dressing, cutting, and painting according to approved methods, using only approved tools and materials. All work to trees shall be reformed by a licensed arborist.

E. The protection, removal, and replacement of existing physical features along the line of work or near the work shall be a part of the work under the Contract and all costs in connection therewith shall be included in the unit or lump sum prices established under the items in the Bid.

1.11 MAINTENANCE OF TRAFFIC

A. Open pits, trenches, unpaved streets, debris, or other obstructions due to construction that will prevent the normal flow of traffic during an extended construction stoppage, for any reason, shall be minimized. In the event an extended construction stoppage is found to be necessary, Contractor shall, at his own expense, provide normal traffic flow during extended construction stoppage. Extended stoppage will be defined by the Owner.

B. All excavated material shall be placed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards, he shall repair the road surface, provide temporary roadways, erect wheel guards or fences, or take other safety measures which are satisfactory to the Engineer and Owner.

C. Detours around construction areas will be subject to the approval of the Owner and the Engineer. Where detours are permitted, the Contractor shall provide all necessary barricades and signs as required to divert the flow of traffic. While traffic is detoured, the Contractor shall expedite construction operations and periods when traffic is being detoured will be strictly controlled by the Owner.

1.12 WATER FOR CONSTRUCTION PURPOSES

A. ~~Owner~~ *Contractor* shall provide water for construction purposes. ~~Contractor shall comply with Owners requirement on timing, flow and pressure.~~ *Paragraph 3.05 B deleted by bid addendum no. 1*

B. ~~Owne~~r *Contractor* shall provide water for hydrostatic and leakage testing one time. ~~Subsequent water used for test shall be paid for by the Contractor.~~ *Paragraph 3.05 B deleted by bid addendum no. 1*

C. Leakage tests for basins shall be performed on individual basins.

D. The Contractor shall be responsible for paying for all water needed to preform retest due to failed prior test.

1.13 MAINTENANCE OF FLOW

A. The Contractor shall at his own cost, provide for the flow of sewers, drains and water courses interrupted during the progress of the work and shall immediately cart away and remove all offensive matter. The entire procedure of maintaining existing flow shall be fully discussed with the Engineer and Owner well in advance of the interruption of any flow.

1.14 CLEANUP

A. During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as is possible. He shall dispose of all residue resulting from the construction work and at the conclusion of the work, he shall remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures, and any other refuse remaining from the construction operations and shall leave the entire site of the work in a neat and orderly condition. All areas shall be graded to drains. All disturbed areas shall be grassed. All pavement and walkways shall be cleaned.

1.15 COOPERATION WITHIN THIS CONTRACT

A. All firms or person authorized to perform any work under this Contract shall cooperate with the General Contractor and his subcontractors or trades and shall assist in incorporating the work of other trades where necessary or required.

B. Cutting and patching, drilling, and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

C. Contractor shall cooperate with MBR manufacturer.

1.16 PROTECTION OF CONSTRUCTION AND EQUIPMENT

A. All newly constructed work shall be carefully protected from injury in any way. No wheeling or walking or placing of heavy loads on it shall be allowed and all portions injured shall be reconstructed by the Contractor at his own expense.

B. All structures shall be protected in a manner approved by the Owner. Should any of the floors or other parts of the structures become heaved, cracked, or otherwise damaged, all such damaged portions of the work shall be completely repaired and made good by the Contractor, at his own expense and to the satisfaction of the Owner. If, in the final review of the work, any defects, faults, or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation or the materials and labor required.

Further, the Contractor shall be fully responsible for the satisfactory maintenance and repair of the construction and other work undertaken herein, for at least the warranty period describe in the Contract.

1.17 CONSTRUCTION WITHIN RIGHT-OF-WAY

A. Where pipe lines are installed within the DOT right-of-way, all excavation backfill and compaction for the purpose of reconstructing roadways and adjacent slopes contiguous thereto shall be in accordance with the DOT or County Standards and Specifications, whichever is applicable. Contractor shall satisfy the authorized representative of the DOT with respect to proper safety procedures, construction methods, required permitting, etc., within the DOT right-of-way.

1.18 CLEANUP AND DISPOSAL OF EXCESS MATERIAL

A. During the course of the work, the Contractor shall keep the site of his operations in as clean and as neat a condition as is possible. He shall dispose of all residue resulting from the construction work and, at the conclusion of the work, shall remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures, and any other refuse remaining from the construction operations, and shall leave the entire site of the work in a neat and orderly condition.

B. In order to prevent environmental pollution arising from the construction activities related to the performance of this Contract, the Contractor and his subcontractors shall comply with all applicable Federal, State, and local laws, and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and elsewhere in the Specifications.

C. The Contractor is advised that the disposal of excess excavated material in wetlands, stream corridors, and plains is strictly prohibited even if the permission of the property owner is obtained. Any violation of this restriction by the Contractor or any person employed by him will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. Therefore, the Contractor will be required to remove the fill at his own expense and restore the area impacted.

PART 2 – PRODUCTS

None this Section.

PART 3 – EXECUTION

None this Section.

END OF SECTION

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SECTION 01 21 00

ALLOWANCES

SECTION 01 21 00

ALLOWANCES

PART 1 – GENERAL

1.01 SUMMARY

A. This section includes administrative and procedural requirements governing allowances.

1. Certain materials and equipment are specified in the Contract Documents by allowances. In some cases, these allowances include installation. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment and defer definition of work to a later date when additional information is available for evaluation. Allowances are also used when the exact scope, quantity or type of work product is unknown.

B. The Contractor shall include in the Base Bid Contract Sum all allowances stated in the Contract Documents. These allowances shall cover the cost of the fees, processing, licenses, materials, labor, equipment and related required items. Allowances shall include all applicable taxes. The Contractor's scheduling, handling costs on the site, unloading, uncrating, cleaning, secure storage and protection, labor, installation costs, administration, supervision, interest, bonds, insurance, all applicable taxes, overhead, profit and other related costs (including but not limited to required permits, inspections, certifications, and testing) shall be included in the Contract Base Bid and not in the allowances.

C. Amounts specified below pertain to all applicable costs.

D. The Contractor shall provide a copy of all paid invoices with the description of the work performed or fees paid for applicable allowance items, to the Owner, with monthly Pay Request Application.

E. All allowances shall be included in the Base Bid.

F. Contractor is responsible for losses incurred from allowance items that are damaged while under his care, such as while stored or during installation.

G. Owner may adjusted individual allowance amounts by transferring an amount between allowances if needed. Written confirmation is required to transfer limit amount.

1.02 SELECTION AND PURCHASE

A. At the earliest practical date after award of the Contract, Contractor shall advise Engineer in writing of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the work.

B. Include all allowances and the dates when a decision on an allowance is needed from Owner in project schedule. The Contractor's schedule should account for the time required to obtain competitive prices.

C. At Engineer's request, Contractor shall obtain proposals for each allowance for use in making final selections. Proposals shall include recommendations that are relevant to performing the work.

D. Purchase products and systems selected or approved by Owner and Engineer from the designated supplier.

1.03 SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances, in the forms specified for Change Orders.

B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

1.04 UNUSED MATERIALS

A. Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.

1. If requested by Engineer, prepare unused material for storage by Owner when it is not economically practical to return the material for credit. If directed by Engineer, deliver unused material to Owner's storage space. Otherwise, disposal of unused material is Contractor's responsibility.

2. If allowance is not used in whole or in part, the Owner shall remove an allowance from the construction contract by change order based on the value listed for the associated unit price.

1.05 COORDINATION

A. Coordinate allowance items with other portions of the work. Furnish templates as required to coordinate installation.

1.06 ADJUSTMENT OF ALLOWANCE COSTS

A. General

1. If the cost, when determined, is more or less than the allowance, the Contract Sum shall be adjusted accordingly by change order, which will include overhead and profit for any increase or decrease from the original allowance. The Contractor is not entitled to all or any part of an unexpended balance of the allowance.

B. Documentation

1. Submit documentation for costs or other expenses under the allowance, within ten days after completion of execution of the work or when requested by Engineer prior to execution of the work.

2. Failure to submit claims within the designated time will constitute a waiver of claims for additional costs.

3. At contract closeout, reflect all approved changes in contract amounts in the final statement of accounting.

PART 2 – SCHEDULE OF CASH ALLOWANCES

All allowances noted below shall be included in the Lump Base Sum bid amount.

2.01 UTILITY RELOCATION FEES

Allow $10,000.00 to pay utility company or companies for providing or removing and replacing as necessary or relocating existing power, telephone, or communication lines to accommodate the work that is not specifically shown on the drawings. Utilities to be relocated or replaced shown on the drawings shall be included in the Contractor's base bid, but not in the allowance.

2.02 CONTINGENCY ALLOWANCE:

Include in the contract lump sum price a contingency allowance in the amount of $30,000.00 as a contingency amount to be used only at the direction of the Owner.

2.03 WORK NOT INCLUDED IN ALLOWANCE ITEMS:

All utilities noted on the plans to be relocated shall not be included in the allowance item. Also, utilities damaged during construction shall not be considered an Allowance item. Any work noted on plans shall not be included in the allowance. All testing required by the specification shall not be included in the allowance.

PART 3 – EXECUTION

3.01 PREPARATION

A. Contractor shall examine products covered by an allowance promptly upon delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

B. Contractor shall coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

END OF SECTION

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SECTION 01 30 00

SPECIAL PROJECT PROCEDURES

SECTION 01 30 00

SPECIAL PROJECT PROCEDURES

PART 1 - GENERAL

1.01 PERMITS AND BUSINESS LICENSES

A. Upon notice of award, the Contractor shall immediately apply for all applicable permits not previously obtained by the Owner to do the work from the appropriate governmental agency or agencies and applicable business licenses. These permits include but are not limited to a SC Contractors License and local building permit and related. No work shall commence until all applicable permits and licenses have been obtained and copies delivered to the Engineer. The costs for obtaining all permits and licenses shall be borne by the Contractor.

1.02 CONNECTIONS TO EXISTING SYSTEM

A. The Contractor shall perform all work necessary to locate, excavate and prepare for connections to the terminus of the existing systems all as shown on the Drawings or where directed by the Owner or Engineer. The cost of this work and for the actual connection to the existing systems shall be included in the price bid for the project and shall not result in any additional cost to the Owner.

1.03 RELOCATIONS

A. The Contractor shall be responsible for the coordination of the relocation or protection of structures, including but not limited to light poles, power poles, signs, sign poles, fences, piping, conduits, and drains that interfere with the positioning of the work as set out on the Drawings. No relocation of the items under this Contract shall be done without approval from the Engineer.

1.04 EXISTING UNDERGROUND PIPING, STRUCTURES, AND UTILITIES

A. The attention of the Contractor is drawn to the fact that during excavation, the possibility exists of the Contractor encountering various water, sewer, gas, telephone, communication, electrical, or other utility lines now shown on the Drawings. The Contractor shall exercise extreme care before and during excavation to locate and flag these lines so as to avoid damage to the existing lines. Cost for relocation of <u>all</u> existing lines shall be included in the price bid for the project. Should damage occur to an existing line, the Contractor shall bear the cost of all repairs.

B. It is the responsibility of the Contractor to ensure that all utility or other poles, the stability of which may be endangered by the close proximity of excavation, are temporarily stayed in position while work proceeds in the vicinity of the pole and that the utility or other companies concerned be given reasonable advance notice of any such excavation by the Contractor.

C. The existing utility locations are shown without express or implied representation, assurance, or guarantee that they are complete or correct or that they represent

a true picture of underground piping to be encountered. The Contractor shall be responsible for notifying the various utility companies to locate their respective utilities in advance of construction in conformance with all requirements provided for in the State and local requirements.

D. The existing piping and utilities that interfere with new construction shall be rerouted as shown, specified or required. Before any piping and utilities not shown on the Drawings are disturbed, the Contractor shall notify the Engineer of the location of the pipeline or utility as directed. Cost for relocation of existing pipelines or utilities shall be included in the price bid for the project.

E. The Contractor shall exercise care in any excavation to locate all existing piping and utilities. All utilities which do not interfere with complete work shall be carefully protected against damage. Any existing utilities damaged in any way by the Contractor shall be restored or replaced by the Contractor at his expense as directed by the Owner and the owner of the utility.

F. Contractor shall protect existing structures to remain and shall not interrupt existing plant operation without prior Owner approval and coordination.

1.05 HURRICANE AND INCLEMENT WEATHER PREPAREDNESS PLAN

A. During hurricane season the Contractor shall submit to the Engineer and Owner a Hurricane Preparedness Plan. The plan should outline the necessary measures which the Contractor proposes to perform at no additional cost to the Owner in case of a hurricane watch and subsequent plan for a hurricane warning and finally for an evacuation.

B. In the event of inclement weather, or whenever Engineer shall advise, Contractor shall insure that he and his Subcontractors shall carefully protect work and materials against damage or injury from the weather. If, in the opinion of the Owner, any portion of work or materials is damaged due to the failure on the part of the Contractor or Subcontractor to protect the work, such work and materials shall be removed and replaced at the expense of the Contractor.

1.06 POWER SUPPLY

A. Electricity as may be required for construction and permanent power supply shall be secured and purchased by the Contractor.

1.07 DEWATERING

A. The Contractor shall conduct groundwater pumping necessary to prevent flotation of any part of the work during construction operations with his own equipment.

B. The Contractor shall pump out water and wastewater which may seep or leak into the excavations for the duration of the Contract and with his own equipment. He shall dispose of this water in an appropriate manner, without causing any siltation of downstream acres or drainage facility.

C. Contractor shall dewater as needed to perform the work or conduct testing at no additional cost to the Owner.

1.08 PUBLIC NUISANCE

A. The Contractor shall not create a public nuisance including but not limited to encroachment on adjacent lands, flooding of adjacent lands, excessive noise or dust, soil vibration or working outside the hours of 8:00 AM to 5:00 PM or working on Saturday and Sunday except by prior approval.

B. Sound levels must meet local ordinances and be no more than 90dBA. No exposure over OSHA regulations is allowed. Sound levels in excess of such are sufficient cause to have the work halted until equipment can be quieted to these levels. Work stoppage by the Owner or regulatory agency for excessive noise shall not relieve the Contractor of the other portions of this specification including, but not limited to, contract time and contract price.

C. Contractor shall continually monitor during the life of the activity vibration from pile driving, soil vibration and similar compaction. Soil vibration activities measurable vibration outside the project site boundary is not allowed. Contractor shall submit monitoring results to Owner and Engineer.

D. No extra charge may be made for time lost due to work stoppage resulting from the creation of a public nuisance.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

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SECTION 01 31 00

ADMINISTRATIVE REQUIREMENTS

SECTION 01 31 00

ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Coordination and project conditions.

B. Field engineering.

C. Preconstruction meeting.

D. Site mobilization meeting.

E. Progress meetings.

F. Pre-installation meetings.

1.02 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and work of various sections of specifications to ensure efficient and orderly sequence of installation of interdependent construction elements.

B. Verify utility requirements and characteristics of operating equipment are compatible with site utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.

C. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. In finished areas, conceal pipes, and wiring within construction. Coordinate locations of fixtures and outlets with finished elements.

E. Coordinate completion and clean-up of work of separate sections in preparation for Substantial Competition. After Utility occupancy of premises, coordinate access to site and operations for correction of defective Work.

1.03 PRECONSTRUCTION MEETING

A. Engineer will schedule meeting after Notice of Award.

B. Attendance Required: Utility, Engineer, Contractor and applicable Subcontractors.

C. Agenda:

1. Submission of lists of products, schedule of values, and progress schedule.

2. Designation of personnel representing parties in Contract, Utility.

3. Procedures and processing of field decisions, submittals, and substitutions, applications for payments, proposal request, Change Orders, and Contract Scheduling.

4. Procedures for maintaining record documents.

5. Scope of Work.

1.04 SITE MOBILIZATION MEETING

A. Engineer and Contractor shall schedule meeting at Project site prior to Contractor occupancy.

B. Attendance Required: Engineer, Utility, Contractor, and major Subcontractors.

C. Agenda:

1. Utility requirements and schedule of closing the existing station during the pump replacement.

2. Construction facilities and controls.

3. Temporary utilities.

4. Survey and layout.

5. Schedules.

6. Procedures for testing.

7. Requirements for start-up of equipment.

8. Inspection and acceptance of equipment put into service during construction period.

1.05 PROGRESS MEETINGS

Schedule and administer meetings throughout progress of the Work at maximum bi-monthly intervals.

A. Make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.

B. Attendance Required: Job superintendent, major subcontractors and suppliers, Utility, Engineer, as appropriate to agenda topics for each meeting.

1.06 PRE-INSTALLATION MEETINGS

A. When required in individual specification sections, convene pre-installation meetings at Project site prior to commencing work of specific section.

B. Required attendance of parties directly affecting, or affected by, work of specific section.

C. Notify Utility, Contractor and Engineer four days in advance of meeting date.

D. Prepare agenda and preside at meeting:

1. Review conditions of installation, preparation and installation procedures.

2. Review coordination with related work.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

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SECTION 01 45 00

QUALITY CONTROL

SECTION 01 45 00

QUALITY CONTROL

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Quality assurance – control of installation.

B. Tolerances.

C. References and standards.

D. Testing laboratory services.

E. Manufacturer's field services.

1.02 RELATED SECTIONS

A. Section 01 00 01 – General Requirements: Preparation, Procedures, Submittals, Testing.

B. Individual Technical Specification sections: quality assurance requirements, submittals and testing procedures.

1.03 QUALITY ASSURANCE – CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturer's instructions, including each step in sequence.

C. Should manufacturer's instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.04 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturer's tolerances. Should manufacturer's tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions and positions before securing in place.

D. Accessible routes shall not exceed maximum ADA allowable slopes.

1.05 REFERENCES AND STANDARDS

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes, or stated in the Specifications or Drawings.

B. Conform to current versions of referenced standards, except where a specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. The contractual relationships, duties, and/or responsibilities of the parties under Contract with the Owner, including those of the Engineer, shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.06 TESTING SERVICES

A. Contractor will appoint and employ services of an independent firm to perform testing. Contractor shall pay for testing services required by the specifications, except where stated otherwise for Special Inspections.

B. The independent firm will perform tests and other services specified in individual specification sections and as required by the Owner.

C. Testing and source quality control may occur on or off the project site. Perform off–site testing if required by the Specifications, Drawings, or Owner.

D. Copies of the reports will be submitted by the independent firm to the Engineer and Contractor. Reports shall indicate observations and results of tests and shall indicate compliance or non–compliance with applicable requirements.

E. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.

1. Notify Engineer and independent firm 48 hours prior to expected time for requiring sampling, testing and observation services, unless noted otherwise in the Specifications or Drawings.

2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

F. Testing does not relieve Contractor to perform Work to contract requirements.

G. Re–testing required because of non–conformance to specified requirements shall be performed by the same independent firm under the direction of the Engineer. Payment for re–testing shall be made by the Contractor.

1.07 MANUFACTURER'S FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, observe conditions of surfaces and installations, monitor quality of workmanship, provide training and instructions to operators, and provide start–up, testing, adjustment, and balancing of equipment, as applicable.

B. If a manufacturer's representative observes faulty practices on site related to or affecting their product, they shall report it immediately to the Contractor and Owner.

C. Observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturer's written instructions shall be documented in writing and provided to the Contractor and Engineer.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Verify utility services are available, of the correct characteristics, and in the correct locations.

3.02 PREPARATION

A. Prepare surfaces in accordance with the requirements of the individual technical Specification sections.

END OF SECTION

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SECTION 01 45 23

TESTING AND INSPECTING SERVICES

SECTION 01 45 23

TESTING AND INSPECTING SERVICES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Selection and payment.

B. Contractor submittals.

C. Testing agency responsibilities.

D. Testing agency reports.

E. Limits on testing authority.

F. Contractor responsibilities.

G. Schedule of tests.

1.02 RELATED SECTIONS

A. Testing and acceptance required by public authorities.

B. Section 01 00 00 – General Requirements: Manufacturer's certificates.

C. Section 01 77 00 – Closeout Procedures: Project record documents.

1.03 REFERENCES (LATEST REVISION)

A. ASTM C 802 – Practice for Conducting an Interlaboratory Test Program to Determine the Precision of Test Methods for Construction Materials.

B. ASTM C 1077 – Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

C. ASTM C 1093 – Practice for Accreditation of Testing Agencies for Masonry.

D. ASTM D 3740 – Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

E. ASTM D 4561 – Practice for Quality Control Systems for Organizations Producing and Applying Bituminous Paving Materials.

F. ASTM E 329 – Specification for Agencies Engaged in Construction Inspection and/or Testing.

G. ASTM E 543 – Practice for Agencies Performing Nondestructive Testing.

H. ASTM E 548 – Guide for General Criteria Used for Evaluating Laboratory Competence.

I. ASTM E 699 – Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

1.04 SELECTION AND PAYMENT

A. Employment and payment by Contractor for services of an independent testing agency or laboratory to perform specified testing.

B. Employment of testing agency or laboratory in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

1.05 QUALITY ASSURANCE

A. Comply with requirements of practices listed in paragraph 1.03.

B. Laboratory: Authorized to operate in State in which project is located.

C. Laboratory Staff: Maintain a full time registered Engineer on staff to review services.

D. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to either National Bureau of Standards or accepted values of natural physical constants.

1.06 CONTRACTOR SUBMITTALS

A. Prior to start of Work, submit testing laboratory name, address, and telephone number, and names of full time registered Engineer and responsible officer.

B. Submit copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.

1.07 TESTING AGENCY RESPONSIBILITIES

A. Test samples of mixes submitted by Contractor.

B. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.

C. Perform specified sampling and testing of products in accordance with specified standards.

D. Ascertain compliance of materials and mixes with requirements of Contract Documents.

E. Promptly notify Engineer and Contractor of observed irregularities or non–conformance of Work or products.

F. Perform additional tests required by Engineer.

G. Attend preconstruction meetings and progress meetings.

1.08 TESTING AGENCY REPORTS

A. After each test, promptly submit three copies of report to Engineer and to Contractor.

B. Include:

1. Date issued.
2. Project title and number.
3. Name of inspector.
4. Date and time of sampling or inspection.
5. Identification of product and specifications section.
6. Location in the Project.
7. Type of inspection or test.
8. Date of test.
9. Results of tests.
10. Conformance with Contract Documents.

C. When requested by Engineer, provide interpretation of test results.

1.09 LIMITS ON TESTING AUTHORITY

A. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.

B. Agency or laboratory may not approve or accept any portion of the Work.

C. Agency or laboratory may not assume any duties of Contractor.

D. Agency or laboratory has no authority to stop the Work.

1.10 CONTRACTOR RESPONSIBILITIES

A. Deliver to agency or laboratory at designated location, adequate samples of materials proposed to be used requiring testing, along with proposed mix designs.

B. Cooperate with laboratory personnel, and provide access to the Work.

C. Provide incidental labor and facilities:

1. To provide access to Work to be tested.
2. To obtain and handle samples at the site or at source of products to be tested.
3. To facilitate tests.
4. To provide storage and curing of test samples.

D. Notify Engineer and laboratory 48 hours prior to expected time for operations requiring testing services.

E. Employ services of an independent qualified testing laboratory and pay for additional samples and tests required by Contractor beyond specified requirements.

1.11 SCHEDULE OF TESTS

A. Below is a schedule of tests for the civil work. Tests related to building are elsewhere.

Section	Test	Frequency	Date	Performed By	Notes
03 30 00 – Cast–in–Place Concrete					
	Materials	As necessary			
	Mix Designs	1 per mix design			
	Strength	4 Test Cylinders for each 50 cy or less or each mix design placed daily			
	Slump	1 test per each set of cylinders			
	Air Content	1 test per each set of cylinders			
	Temperature	1 test per each set of cylinders			
31 00 00 – Earthwork					
	Compaction				
	Unpaved	1 test per horizontal layer per 10,000 sf of fill area			
	Paved	1 test per horizontal layer per 5,000 sf of subgrade			
	Building Pad	1 test per horizontal layer per 1,500 sf of fill area			
	Proof Rolling	As necessary			
32 11 23 – Aggregate Base Courses					
	Base Density	1 test per 5,000 sf			
32 12 16 – Asphalt Paving					
	Asphalt Extraction & Gradation	1 test for each 250 tons placed			
	Marshall Stability	1 test for each 250 tons placed			
	Field Density	1 test for each 250 tons placed			
	Cores	1 test for each 250 tons placed			

Water Utilities					
	Hydrostatic & Leakage	1.5 times the working pressure (no less than 150 psi). Conducted for 2 hours with maintained pressure of 150 psi (200 psi on fire main)			
	Bacteriological Samples	2 taken 24 hours apart after disinfection			
	Compaction				
	Traffic Areas	1 per 100 lf or less for each 4 ft. of depth			
	Non–Traffic Areas	1 per 500 lf or less for each 4 ft. of depth			
	Fire Flow	1 per permit			
Sanitary Sewage Utilities					
	Television Inspection of Sewers	As requested			
	Leakage	As necessary			
	Compaction				
	Traffic Areas	1 per 100 lf or less for each 4 ft. of depth			
	Non–Traffic Areas	1 per 500 lf or less for each 6 ft. of depth			
	Gravity – Air	All lines			
	Hydrostatic – Force Main	100 psi for 2 hours			
	Deflection	100% of the system			
Storm Drainage Utilities					
	Compaction				
	Traffic Areas	1 per 100 lf or less for each 4 ft. of depth			
	Non–Traffic	1 per 500 lf or less for each 6 ft. of depth			

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

Not Used

END OF SECTION

INDEX TO

SECTION 01 50 00

TEMPORARY CONSTRUCTION FACILITIES

SECTION 01 50 00

TEMPORARY CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Site Plan

1. The Contractor shall prepare a site plan indicating the proposed location and dimensions of any area to be fenced and used by the Contractor, the number of trailers to be used, avenues of ingress or egress to the fenced area and details of the fence installation. Any areas which may have to be graveled to prevent the tracking of mud shall also be identified. The Contractor shall also indicate if the use of a supplemental or other staging area is desired.

B. Identification of Employees

1. The Contractor shall be responsible for furnishing to each employee, and for requiring each employee engaged on the work to display, identification as approved and directed by the Owner. Prescribed identification shall immediately be delivered to the Owner for cancellation upon release of any employee. When required, the Contractor shall obtain and provide fingerprints of persons employed on the project. Contractor and subcontractor personnel shall wear identifying markings on hard hats clearly identifying the company for whom the employee works. All personnel shall have badges and vehicle passes or decals to enter the installation. Badges will be required to be worn at all times while on the installation.

C. Employee Parking

1. Contractor employees shall park privately owned vehicles in an area designated by the Owner. Contractor employee parking shall not interfere with existing and established parking requirements of the installation.

1.02 AVAILABILITY AND USE OF UTILITY SERVICES

A. Payment for Utility Services

1. The amount of each utility service consumed shall be charged to or paid for by the Contractor. There shall be no additional cost to the Owner.

B. Meters and Temporary Connections

1. The Contractor, at its expense and in a manner satisfactory to the Owner, shall provide and maintain necessary temporary connections, distribution lines, and meter bases required to measure the amount of each utility used for the purpose of determining charges.

C. Sanitation

1. The Contractor shall provide and maintain within the construction area minimum field-type sanitary facilities approved by the Owner. Owner toilet facilities will not be available to Contractor's personnel.

D. Telephone

1. The Contractor shall make arrangements and pay all costs for telephone facilities desired.

1.03 PROTECTION AND MAINTENANCE OF TRAFFIC

A. During construction the Contractor shall provide access and temporary relocated roads as necessary to maintain traffic. The Contractor shall maintain and protect traffic on all affected roads during the construction period except as otherwise specifically directed by the Owner. Measures for the protection and diversion of traffic, including the provision of watchmen and flagmen, erection of barricades, placing of lights around and in front of equipment and the work, and the erection and maintenance of adequate warning, danger, and direction signs, shall be as required by the State and local authorities having jurisdiction. The traveling public shall be protected from damage to person and property. The Contractor's traffic on roads selected for hauling material to and from the site shall interfere as little as possible with public traffic. The Contractor shall investigate the adequacy of existing roads and the allowable load limit on these roads. The Contractor shall be responsible for the repair of any damage to roads caused by construction operations. Any changes in traffic patterns or restrictions shall be approved by the Owner.

B. Barricades

1. The Contractor shall erect and maintain temporary barricades to limit public access to hazardous areas. Such barricades shall be required whenever safe public access to paved areas such as roads, parking areas, or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic. Barricades shall be securely placed, clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.

1.04 CONTRACTOR'S TEMPORARY FACILITIES

A. Administrative Field Offices

1. The Contractor shall provide and maintain administrative field office facilities within the construction area at the designated site if so needed. Existing office and warehouse facilities will not be available to the Contractor's personnel. Office shall be located where it will not interfere with the progress of the work nor the Owners existing operations.

B. Storage Area

1. The Contractor shall construct a temporary six-foot high chain link fence around trailers and materials if required. The fence shall include plastic strip inserts, colored brown, so that visibility through the fence is obstructed. Fence posts may be driven, in lieu of concrete bases, where soil conditions permit.

C. Appearance of Trailers

1. Trailers utilized by the Contractor for administrative or material storage purposes shall present a clean and neat exterior appearance and shall be in a state of good repair. Trailers which, in the opinion of the Owner, require exterior painting or maintenance will not be allowed on the property.

D. Maintenance of Storage Area

1. Fencing shall be kept in a state of good repair and proper alignment. Should the Contractor elect to traverse, with construction equipment or other vehicles, grassed or unpaved areas which are not established roadways, such areas shall be covered with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established roadways; gravel gradation shall be at the Contractor's discretion. Grass located within the boundaries of the construction site shall be mowed for the duration of the project. Grass and vegetation along fences, buildings, under trailers, and in areas not accessible to mowers shall be edged or trimmed neatly.

E. Security Provisions

1. Adequate security provisions shall be provided at the Contractor's temporary facilities. The Contractor shall be responsible for the security of its own equipment; in addition, the Contractor shall notify the appropriate law enforcement agency requesting periodic security checks of the temporary project field office.

F. Sanitary and Waste Disposal Facilities

1. The Contractor shall provide sanitary facilities for their workers, Owner, Engineer, visitors, and applicable regulatory personnel. Provide waste collections containers to handle waste from construction personal and operations.

1.05 TEMPORARY PROJECT SAFETY FENCING

A. As soon as practicable, but not later than 15 days after the date established for commencement of work, the Contractor shall furnish and erect temporary project safety fencing at the work site. The safety fencing shall be a high visibility orange colored, high density polyethylene grid or approved equal, a minimum of 42 inches high, supported and tightly secured to steel posts located on maximum 10-foot centers, constructed at the approved location. The safety fencing shall be maintained by the Contractor during the life of the contract and, upon

completion and acceptance of the work, shall become the property of the Contractor and shall be removed from the work site.

1.06 TEMPORARY FIRE PROTECTION

A. Install and maintain temporary fire-protections facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with Fire Department requirements.

B. Prohibit smoking in construction areas.

C. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.

D. Develop and supervise an overall fire-prevention and protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

E. Provide temporary fire protection suitable to the fire department.

1.07 PROTECTION

A. Contractor is responsible to provide such covering, shields, and barricades as are required to protect building occupants, equipment, stores, supplies, etc., from dust, debris, weather intrusion, water, moisture, or other cause of damage resulting from construction.

1.08 CLEANUP

A. Construction debris, waste materials, packaging material, and the like shall be removed from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways shall be cleaned away. Materials resulting from demolition activities which are salvageable shall be stored within the fenced area described above or at the supplemental storage area. Stored material not in trailers, whether new or salvaged, shall be neatly stacked when stored.

1.09 RESTORATION OF STORAGE AREA

A. Upon completion of the project and after removal of trailers, materials, and equipment from within the fenced area, the fence shall be removed and will become the property of the Contractor. Areas used by the Contractor for the storage of equipment or material, or other use, shall be restored to the original or better condition. Gravel used to traverse grassed areas shall be removed and the area restored to its original condition, including top soil and seeding as necessary.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

INDEX TO

SECTION 01 56 39

TEMPORARY TREE AND PLANT PROTECTION

SECTION 01 56 39

TEMPORARY TREE AND PLANT PROTECTION

PART 1 – GENERAL

1.01 QUALITY ASSURANCE

A. Contractor shall provide at least one person who shall be present at all times during planting and pruning. Individual shall be thoroughly familiar with types of plants and trees involved and shall be responsible for directing the digging, cutting, planting, and maintenance of designated plant and tree materials.

B. Qualifications: Repair of tree damage shall be completed or supervised by a tree surgeon who is a member of the National Arborist Association.

C. Pre–Work Conference – Review on site with the Owner.

D. **Trees to be removed will be marked with green flagging. Trees to remain will be marked with red flagging. Trees designated as "SPECIMEN" will be marked with yellow flagging.**

PART 2 – PRODUCTS

2.01 MATERIALS

A. Provide tree protection materials, as detailed on the construction drawings.

PART 3 – EXECUTION

3.01 PROTECTION OF SPECIMEN TREES

A. Any irreparable damage to roots, trunk or bark, or any unauthorized cutting or pruning of limbs to trees designated by the Owner as "specimen" will result in a fine. This fine shall be levied through the Application for Payment as retainage and shall be used to supplement "specimen" with tree of similar value and to perform extensive "state of the art" tree surgery in an attempt to save the tree.

3.02 METHODS OF PROTECTION

A. Use the following method to protect specimen trees. Actual determination of extent and combination of methods shall be determined on site.

B. Temporary Fence Enclosures: Construct protective fencing where indicated on the construction drawings. Protective fencing shall be installed a minimum of three feet beyond the dripline. No grading, trenching, pruning, or storage of materials shall be allowed inside this area.

3.03 REPAIR OF TREES INJURED DURING CONSTRUCTION

A. Contractor shall:

1. Repair damaged trees promptly to prevent progressive deterioration caused by damage.

2. Repair to trees damaged during construction according to standard arborcultural techniques recognized by International Society of Arborculture.

3. Remove trees damaged beyond satisfactory repair as determined by Owner. Refer to FINES AND MITIGATION in this section for loss of specimen trees.

4. Temporarily cover roots exposed during construction with wet burlap to prevent roots from drying out. Cover roots with earth as soon as possible.

5. Roots Cut During Construction: Coat roots 1 1/2 inches diameter or larger with antiseptic paint.

3.04 FINES

A. Fine values for designated **"SPECIMEN"** vegetation shall be determined by the following:

Caliper	Fine
1 inch – 2 inches	$ 150.00
2 inches – 3 inches	$ 200.00
3 inches – 4 inches	$ 250.00
4 inches – 5 inches	$ 400.00
5 inches – 6 inches	$ 500.00
6 inches – 7 inches	$ 600.00
7 inches – 8 inches	$ 750.00
8 inches – 11 inches	$ 1,500.00
12 inches – 20 inches	$ 2,000.00
21 inches & larger	$ 2,500.00

3.05 MITIGATION

A. Mitigation shall be in the form of tree transplantation. Plant materials shall be from off–site (for smaller sites) or from remote areas on site. Trees shall be comparable in size, form, and species to lost "specimen" tree. Tree species, size, and planting locations shall be approved by the Owner.

END OF SECTION

INDEX TO

SECTION 01 65 00

SHIPMENT, PROTECTION, AND STORAGE

SECTION 01 65 00

SHIPMENT, PROTECTION, AND STORAGE

PART 1 – GENERAL

1.01 GENERAL

A. Equipment, products and materials shall be shipped, handled, stored, and installed in ways which will prevent damage to the items. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Owner and Engineer. Additional delivery, handling, and storage requirements, specific to an individual product, may be provided in the appropriate Specification sections.

1.02 TRANSPORATION AND DELIVERY

A. Transport and handle items in accordance with manufacturer's printed instructions.

B. Schedule delivery to reduce long term on-site storage prior to installation and operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer.

C. Ship equipment, materialS, and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.

D. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

E. Deliver spare parts at time as pertaining equipment. Deliver spare parts to owner after completion of work.

F. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.

G. Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, packing, protecting and installing.

H. Assume responsibility for equipment material and spare parts just before unloading from carrier at site.

I. All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.

J. Provide equipment and personnel to unload all items delivered to the site.

K. Promptly inspect shipment to assure that products comply with requirements, quantities are correct, and items are undamaged. For items furnished by others (i.e. Owner, other Contractors), perform inspection in the presence of the Engineer. Notify Engineer verbally, and in writing, of any problems

L. Pay all demurrage charges if failed to promptly unload items.

PART 2 – PRODUCTS

2.01 PIPE

A. Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes with paint, tape coatings, linings, or the like shall be stored to protect the coating or lining from physical damage or other deterioration. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.

PART 3 – EXECUTION

3.01 EQUIPMENT

A. PACKAGE AND MARKING:

1. All equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to site. Each item or package shall be marked with the number unique to the specification reference covering the item.

2. Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or subassembled units where possible.

B. IDENTIFICATION:

1. Each item of equipment and valve shall have permanently affixed to it a label or tag with its equipment or valve number designated in this contract. Marker shall be of stainless steel. Location of label will be easily visible.

C. SHIPPING:

1. Bearing housings, vents, and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.

2. Damage shall be corrected to conform to the requirements of the contract before the assembly is incorporated into the Work. The Contractor shall bear the costs arising out of dismantling, inspection, repair, and reassembly.

D. DELIVERY AND HANDLING:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.

2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to Project site in an undamaged, or sensitive to deterioration, theft, and other losses.

4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

E. FACTORY APPLIED COATINGS:

1. Unless otherwise specified, each item of equipment shall be shipped to the site of the Work with the manufacturer's shop applied epoxy prime coating. The prime coating shall be applied over clean dry surfaces in accordance with the coating manufacturer's recommendations. The prime coating will serve as a base for field-applied finish coats. Electrical equipment and materials shall be painted by manufacturer.

F. UNLOADING:

1. Unloaded and handle according to manufacturer’s requirement. Contractor shall unload and store MBR manufacturer’s equipment according to their instruction.

G. STORAGE:

1. During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored in an enclosed space affording protection from weather, dust, and mechanical damage and providing favorable temperature, humidity, and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

2. Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least six inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

   a. Store products to allow for inspection and measurement of quantity or counting of units.

   b. Store materials in a manner that will not endanger Project structure.

c. Store products that are subject to damage by the elements, under cover in a weather-tight enclosure above ground, with ventilation adequate to prevent condensation.

d. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

e. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

f. Protect stored products from damage and liquids from freezing.

H. PROTECTION OF EQUIPMENT AFTER INSTALLATION:

1. After installation, all equipment shall be protected from damage from, including but not limited to, dust, abrasive particles, debris and dirt generated by the placement, chipping, sandblasting, cutting, finishing and grinding of new or existing concrete, terrazzo, and metal; and from the fumes, particulate matter, and splatter from welding, brazing, and painting of new or existing piping and equipment. As a minimum, vacuum cleaning, blowers with filters, protective shieldings, and other dust suppression methods will be required at all times to adequately protect all equipment. During concreting, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switchgear, unit substation, and motor load centers shall not be installed until after all concrete work and sand-blasting in those areas have been completed and accepted and the ventilation systems installed.

END OF SECTION

INDEX TO

SECTION 01 75 15

PUMP STATION – START UP

SECTION 01 75 15

PUMP STATION – START UP

PART 1 - GENERAL

1.01 SUMMARY

A. The Contractor shall:

1. Coordinate a schedule for start-up of various equipment and systems.
2. Notify the Engineer ten working days prior to start-up of each item or station.
3. Clean wet well of all construction debris prior to starting pumps.
4. Verify that each piece of equipment or system had been checked for proper lubrication, drive rotation, belt tension, control sequence, blockage, or other conditions which may cause damage.
5. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
6. Verify wiring and support components for equipment are complete and tested.
7. Execute start-up under supervision of responsible Manufacturer's representative, Utility representative, Engineer, and contractor's personnel in accordance with manufacturer's instructions.
8. Submit a written report that equipment or system had been properly installed and is functioning correctly.

1.02 DEMONSTRATION AND INSTRUCTION

A. In addition to the requirements of Section 1.01 above, the Contractor shall:

1. Demonstrate operation and maintenance of the system to the engineer and utility prior to final acceptance. The Contractor shall provide the equipment manufacturer's representative for a minimum of one half day of training to Utility personnel for each station. The Contractor shall coordinate and schedule demonstration of the system with the Wastewater Division and the engineer.
2. Utilize operation and maintenance manuals as basis for instruction. Review contents on manual with Utility personnel in detail to explain all aspects of operation and maintenance.
3. Demonstrate start-up, operation, control adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at equipment location.
4. Prepare and insert additional data operations and maintenance manuals when need for additional data becomes apparent during instruction.

END OF SECTION

INDEX TO

SECTION 01 77 00

CLOSEOUT PROCEDURES

SECTION 01 77 00

CLOSEOUT PROCEDURES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Closeout procedures.

B. Project record documents.

C. Warranties and bonds.

D. Operation and maintenance data.

E. Maintenance services.

1.02 RELATED SECTIONS

A. Section 01 00 01 – General Requirements.

B. Section 01 99 90 – Reference Forms.

C. Section 01 78 36 - Warranties.

D. Section 01 78 33 - Bonds.

1.03 SUBSTANTIAL COMPLETION PROCEDURES

A. In addition to the requirements in the General Conditions, contractors shall follow these procedures.

1. Contractor's List of Incomplete Items:Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

2. Submittals Prior to Substantial Completion: Complete the following a minimum of ten days prior to requesting review for determining date of Substantial Completion. List items below that are incomplete at time of request.

a. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities.

b. Submit closeout submittals including but not limited to project record documents, operation and maintenance manuals, final completion construction photographic documentation, test results, and similar final record information.

c. Submit maintenance material submittals specified in individual section, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number where applicable.

1. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items including name and quantity of each item and name and number of related Specification Section. Obtain Owner's signature for receipt of submittals.

3. Submit test, adjust, and balance records.

4. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

B. Procedures Prior to Substantial Completion: Complete the following a minimum of ten days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.

2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.

3. Complete startup and testing of systems and equipment.

4. Perform preventive maintenance on equipment used prior to Substantial Completion.

5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in individual equipment specifications.

6. Advise Owner of changeover in electric and other utilities.

7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.

8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

9. Remove labels that are not permanent labels.

10. Complete final cleaning requirements, including touch up painting.

11. Touch up and otherwise repair and restore marred exposed finished to eliminate visual defects.

1.04 CLOSEOUT PROCEDURES

A. Submit written verification that the Contract Documents had been reviewed, Work has been observed at appropriate times, and the Work is complete in accordance with Contract Documents and ready for Engineer's review. Request in writing that the Engineer review the work. Then address all punch lists or discrepancy items developed from Engineer, Owner, and State's review.

B. Submit a draft to Engineer of all closeout documents for review at least 15 days prior to substantial completion.

C. Submit project record documents (see item 1.05).

D. Provide closeout submittals to Engineer (see item 1.06).

E. Provide any other submittals to Engineer required by governing or other authorities.

F. Provide Final Adjustment of Accounts (see item 1.07).

G. Provide maintenance services indicated in specification sections for one year from the date of substantial completion.

H. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

I. Site and building shall be cleaned per specifications.

1.05 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:

1. Drawings.

2. Specifications.

3. Addenda.

4. Change Orders and other modifications to the Contract.

5. Reviewed Shop Drawings, Product Data, and Samples.

6. Manufacturer's instructions for assembly, installation, maintenance, and adjustments.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Equipment Specifications: Legibly mark and record at each product section description of actual products installed, including the following:

1. Manufacturer's name and product model and number.

2. Product substitutions or alternates utilized.

3. Changes made by Addenda and modifications.

F. Project Record Drawings: Legibly mark each item to record actual construction including:

1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.

3. Where proposed and existing utilities cross, the Contractor shall measure and record the horizontal location and vertical separation between each crossing. Separation shall be measured between exteriors and pipes.

4. Field changes of dimension and detail.

5. Details not on original Contract drawings.

6. An as built of the construction with spot elevations and finished contours of the detention pond and all storm pipes/inlets.

7. An as-built of the sanitary sewer, water and storm drainage systems.

8. Record drawings for building, conduits, structures, and electrical, power, communications and related.

9. Piling data locations, tip and cut-off elevations and driving records.

10. Building MEP and other building features (with changes).

G. Record drawing shall be prepared according to these conditions: The Contractor shall keep accurate, legible records of the locations, types, and sizes of sanitary lines, service laterals, manholes, cleanouts, water lines, fittings, valves, hydrants, drainage pipes, drainage structures, and other related work performed under this project. Where proposed and existing utilities cross, the Contractor shall measure and record the horizontal location and vertical separation between each crossing. Separation shall be measured between exteriors of pipes. On a set of project prints provided by the Owner, the Contractor shall prepare a set of "record" drawings from the data stated above. The horizontal locations of all portions of items installed on this project shall be accurately tied down to features that are physical and visible, such as property corner markers and permanent type structures. Invert elevations of all manholes, storm sewers and structures, sanitary sewers, and lift stations shall be clearly indicated. These

"record" drawings shall be kept clean and dry and maintained in a current state with the progress of the work. If at any time, a copy of this plan or portion of it is requested by the Owner, such copy shall be made available within 24 hours after the request is made.

Before final acceptance of the completed installation and final payment by the Owner, the Contractor shall deliver to the Engineer, three sets of "Record" Drawings accurately depicting the horizontal and vertical as–built data described in the above paragraph. "Record" drawings for the items installed on this project shall be certified by a licensed surveyor, other than Thomas & Hutton, registered in South Carolina. The size of the drawings shall be 24" x 36". The "Record" drawings shall have a coordinate system based on the South Carolina State Plane Coordinate System, East Zone, North American Datum of 1983 (NAD83). Elevations shall be based on the North American Vertical Datum of 1929 (NGVD 29). All measurements and coordinates shown shall use the U.S. Survey flood definition. Coordinates shall be shown on all drainage storm manholes/boxes and all other related work performed under this contract, including an as built condition of the detention pond with spot elevations and finished 1-foot contours. Vertical data including but not limited to, structure and manhole frame and inverts, pipe inverts, control levels, bottom, site grading, and as-built grading shall be shown. In addition to the "Record" drawings, Contractor shall deliver to Engineer electronic AutoCAD (v. 14 or later) files of all the data described above on a CD-ROM.

H. Deliver final project record drawing files to Engineer in an electronic AutoCAD (v.14 or later) and three paper sets. Find project record drawing shall include Engineer comments and shall conform to regulatory agency requirements.

I. Submit final documents to Engineer at least 15 days prior to claim for final Application for Payment.

1.06 CONTRACTOR'S CLOSEOUT SUBMITTAL TO ENGINEER

A. Closure of the construction contract, including final payment to the Contractor, requires the following:

1. Contractor's submission to the Engineer of the following:

a. Project record drawings.

b. An affidavit, in the form of the AIA G706, that wages, bills for materials and equipment, and other indebtedness connected with the work have been paid (Contractor's affidavit of payment & debt and claims);

c. A certificate in the form of AIA G715 (Accord for Certificate of Insurance) issued by an authorized representative of the Contractor's insurance company certifying completed project insurance coverage as required by the contract documents;

d. A statement that the Contractor knows of no reason that the completed project insurance will not be renewable to cover the period required by the Contract Documents;

e. Consent of surety, if any, to final payment, in the form of AIA G707 (Consent of Surety to Final Payment);

f. Other information required by the Owner establishing the Contractor's payment or satisfaction of obligations, such as receipts, releases and waivers of liens, claims and security interests arising out of the contract, all in the forms as designated by the Owner;

g. Inspection reports that may not be a part of the record documents;

h. All warranties and quantities;

i. O&M Manuals;

j. Training Manuals;

k. Final Adjustment of Accounts; and

l. A list of all claims against Owner that the Contractor believes is unsettled.

m. Other documents required by the Owner and State guidelines and requirements,

1.07 FINAL ADJUSTMENT OF ACCOUNT

A. Submit a final statement of accounting to the Engineer.

B. Statement shall reflect all adjustments to the contract sum:

1. The original contract sum.

2. Additions and deductions resulting from:

a. Previous change orders;

b. Unit prices;

c. Penalties and bonuses;

d. Deductions for liquidated damage; and

e. Other adjustments.

3. Total contract sum, as adjusted.

4. Previous payments.

5. Remaining sum due.

1.08 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit as directed in Section 01 78 23 Operating and Maintenance Information.

1.10 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Provide spare parts, maintenance, and extra Products in quantities specified in individual specification sections.

B. Deliver to location as directed; obtain receipt prior to final payment.

C. Crate in containers designed for prolonged storage suitable for handling with hoisting equipment containers.

D. Stencil contents on containers

1.11 WARRANTIES AND BONDS

A. Provide duplicate notarized copies and a PDF of each.

B. Execute and assemble transferable warranty documents from Subcontractors, suppliers, and manufacturers.

C. Provide Table of Contents and assemble in three D side ring binder with durable plastic cover.

D. Submit prior to final Application for Payment.

E. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

1.12 MAINTENANCE SERVICE

A. Furnish service and maintenance of components indicated in specification sections for one year from date of Substantial Completion.

1. Manufacturer or Supplier name.

2. Unit name, specific part name.

3. Manufacturers catalogue number or other identifying information.

4. Precautionary information.

B. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.

C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.

D. Maintenance service shall not be assigned or transferred to any agent or Subcontractor without prior written consent of the Owner.

1.13 FINAL CLEANING

A. Execute final cleanup prior to final project acceptance.

B. Remove waste and surplus materials, rubbish, and construction facilities from the site.

C. Clean all exterior paved surfaces, establish vegetation or ground cover on all disturbed areas.

D. Clean all sight-exposed interior and exterior surfaces and work areas.

E. Clean debris and sediment from all new storm pipes and structures.

F. Repair all cracked or damaged curbs, sidewalks and concrete areas. If the crack is irregular or goes through the full depth of the concrete, remove the damaged section and replace.

G. Removal all soil and other debris from the new storm system, curb, and paved areas.

H. Comply with requirements of Section 01 77 01.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

Not Used

END OF SECTION

INDEX TO

SECTION 01 77 01

CLEANING

SECTION 01 77 01

CLEANING

PART 1 – GENERAL

1.01 RELATED SECTIONS

A. Documents affecting the work of this Section include, but are not necessarily limited to, the General Conditions, the Supplementary Conditions, and other Sections in Division 1 of these Specifications.

B. In addition to standard described in this Section, comply with requirements for cleaning as described in pertinent other Sections of these Specifications.

1.02 DESCRIPTION OF WORK INCLUDED

A. Throughout the construction period, maintain the buildings and site in a standard of cleanliness as described in this Section.

B. Execute cleaning during progress of the work and at completion of the work.

1.03 QUALITY ASSURANCE

A. Conduct daily inspection, and more often if necessary, to verify that requirements for cleanliness are being met.

B. In addition to the standards described in this Section, comply with pertinent requirements of governmental agencies having jurisdiction.

C. Conduct cleaning and disposal operations to comply with all Federal, State, and local codes, ordinances, regulations, and anti-pollution laws.

PART 2 – PRODUCTS

2.01 CLEANING MATERIALS AND EQUIPMENT

A. Provide required personnel, equipment, and materials needed to maintain the specified standard of cleanliness.

B. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

C. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

D. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

2.02 COMPATIBILITY

A. Use only the cleaning materials and equipment which are compatible with the surface being cleaned, as recommended by the manufacturer of the material.

PART 3 – EXECUTION

3.01 PROGRESS CLEANING

A. General

1. Retain stored items in an orderly arrangement allowing maximum access, not impeding traffic or drainage, and providing protection of materials.

2. Do not allow accumulation of scrap, debris, waste material, and other items not required for construction of the work.

3. At least twice each month, and more often if necessary, completely remove all scrap, debris, and waste material from the job site.

4. Provide adequate storage for all items awaiting removal from the job site, observing requirements for fire protection and protection of the environment.

5. Execute periodic cleaning to keep the work, the site and adjacent properties free from accumulation of waste materials, rubbish, and wind-blow debris, resulting from construction operations.

B. Site

1. Daily, and more often if necessary, inspect the site and pick up all scrap, debris, and waste material. Remove such items to the place designated for their storage.

2. Weekly, and more often it necessary, inspect all arrangements of materials stored on the site. Restack, tidy, or otherwise service arrangements to meet the requirements of paragraph 3.01, part A, Section 1.

3. Maintain the site in a neat and orderly condition at all times.

4. Provide onsite containers for the collection of waste materials, debris and rubbish. Empty as necessary to prevent overflow and nuisance odor.

C. Structures

1. Weekly, and more often if necessary, inspect the structures and pick up all scrap, debris, and waste material. Remove such items to the place designated for their storage.

2. Weekly, and more often if necessary, sweep interior spaces clean ("Clean", for the purpose of this subparagraph shall be interpreted as meaning free from dust and other material capable of being removed by use of reasonable effort and a hand-held broom).

3. As required preparatory to installation of succeeding materials, clean the structures of pertinent portions thereof to the degree of cleanliness recommended by the manufacturer of the succeeding material, using equipment and materials required to achieve the necessary cleanliness.

4. Following the installation of finish floor materials, clean the finish floor daily (and more often if necessary) at all times while work is being performed in the space in which materials are installed *("Clean", for the purpose of this paragraph, shall be interpreted as meaning free from foreign material which, in the opinion of the Architect orEngineer, may be injurious to the finish floor material).*

3.02 DUST CONTROL

A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

C. Control dust on the site through the use of watering trucks and other accepted means.

3.03 FINAL CLEANING

A. Execute final cleanup prior to final project acceptance.

B. "Clean", for the purpose of this Article, and except as may be specifically provided otherwise, shall be interpreted as meaning the level of cleanliness generally provided by skilled cleaners using commercial quality building maintenance equipment and materials.

C. Prior to completion of the work, remove from the job site all tools, surplus materials, equipment, scrap, debris, and waste. Conduct final progress cleaning as described in Article 3.01.

D. Site

1. Clean project site, yard and grounds disturbed by construction activities. Unless otherwise specifically directed by the Architect or Engineer, broom clean paved areas on the site and public paved areas adjacent to the site and rake clean other surfaces of the grounds. Remove stains, spills, and other foreign deposits.

2. Completely remove resultant debris.

E. Structures

1. Exterior

a. Visually inspect exterior surfaces and remove all traces of soil, waste materials, smudges, and other foreign matter.

b. Remove all traces of splashed materials from adjacent surfaces.

c. If necessary to achieve a uniform degree of cleanliness, hose down the exterior of the structure.

d. In the event of stubborn stains not removable with water, the Architect or Engineer may require light sandblasting or other cleaning at no additional cost to the Owner.

2. Interior

a. Visually inspect interior surfaces and remove all traces of soil, waste materials, smudges and other foreign matter.

b. Remove all traces of splashed material from adjacent surfaces.

c. Remove paint droppings, spots, stains and dirt from finished surfaces.

3. Glass

a. Clean inside and outside

4. Polished surfaces

a. To surfaces requiring routine application of buffed polish, apply the polish recommended by the manufacturer of the material being polished.

5. Replace disposable air filters.

6. Clean ducts, blowers, coil units and HVAC.

F. Remove waste and surplus materials, rubbish, and construction facilities from the site.

G. Clean all exterior paved surfaces, establish vegetation or ground cover on all disturbed areas.

H. Clean all sight-exposed interior and exterior surfaces and work areas.

I. Clean debris and sediment from all new storm pipes and structures.

J. Repair all cracked or damaged curbs. If the crack is irregular or goes thru the full depth of the curb, remove the damaged section and replace.

K. Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

L. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations immediately prior to Occupancy for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.

c. Rake grounds that are neither planted nor paved smooth, even-textured surface.

d. Remove tools, construction equipment, machinery, and surplus material from Project site.

e. Clean exposed exterior and interior finishes to a dirt-free condition, free of grease, dust, stains, films, fingerprints, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

g. Sweep concrete floors broom clean in unoccupied spaces.

h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.

i. Power scrub and power buff resilient flooring surfaces, tile, and fluid-applied flooring.

j. Clean transparent materials, including mirrors and glass in doors windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.

k. Remove labels that are not permanent.

l. Wipe surfaces of mechanical and electrical equipment, elevator equipment where applicable, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.

n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection. Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report on completion of cleaning.

p. Clean lighting fixtures, lamps, globes, and reflectors to functions with full efficiency.

q. Leave Project clean and ready for occupancy.

M. Schedule final cleaning as approved by the Architect or Engineer to enable the Owner to accept a completely clean work.

N. Prior to final completion or Owner occupancy, Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces and all work areas to verify that the entire work is clean.

3.04 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion and final cleaning.

B. Repair of remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repair or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.

2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.

a. Do not paint over “UL” and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

3.05 CLEANING DURING OWNER’S OCCUPANCY

A. Should the Owner occupy the work or any portion thereof prior to its completion by the Contractor and acceptance by the Owner, responsibilities for interim and final cleaning shall be as determined by the Architect or Engineer in accordance with the General Conditions of the Contract.

END OF SECTION

INDEX TO

SECTION 01 78 23

OPERATION AND MAINTENANCE INFORMATION

SECTION 01 78 23

OPERATING AND MAINTENANCE INFORMATION

PART 1 – GENERAL

1.01 SCOPE

A. Operation and maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.

B. O&M instructions must be submitted and accepted before on-site training may start.

PART 2 – INFORMATION

2.01 SUBMISSION OF OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance (O&M) Data specifically application to this contract and a complete and concise depiction of the provided equipment, product, or system. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit in accordance with this section. Provide hard and digital copies.

A. Package Quality

1. Documents must be fully legible. Poor quality copies and material with hole punches obliterating the text or drawings will not be accepted.

B. Package Content

1. Data package content shall be as shown in the paragraph titled “Schedule of Operation and Maintenance Data Packages.” Comply with the data package requirements specified in the individual technical sections, including the content of the packages and addressing each product, component, and system designated for data package submission.

C. Changes to Submittals

1. Manufacturer-originated changes or revisions to submitted data shall be furnished by the Contractor if a component of an item is so affected subsequent to acceptance of the O&M Data. Changes, additions, or revisions required by the Engineer for final acceptance of submitted data, shall be submitted by the Contractor within ten calendar days of the notification of this change requirement.

2.02 TYPES OF INFORMATION REQUIRED

A. GENERAL:

1. O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. In addition, one or more of the following items of information shall be provided as applicable.

B. OPERATING INSTRUCTIONS:

1. Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:

a. SAFETY PRECAUTIONS: List personnel hazards for equipment and list safety precautions for all operating conditions.

b. OPERATOR PRESTART: Provide requirements to set up and prepare each system for use.

c. START-UP, SHUTDOWN, AND POST SHUTDOWN PROCEDURES: Provide a control sequence for each of these operations.

d. NORMAL OPERATIONS: Provide control diagrams with data to explain operation and control of systems and specific equipment.

e. EMERGENCY OPERATIONS: Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.

f. OPERATOR SERVICE REQUIREMENTS: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.

g. ENVIRONMENTAL CONDITIONS: Provide a list of environtmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

C. PREVENTIVE MAINTENANCE:

1. The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:

a. LUBRICATION DATA: Provide lubrication data, other than instructions for lubrication, in accordance with paragraph 2.0-B6.

1. A table showing recommended lubricants for specific temperature ranges and applications;

2. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and

3. A lubrication schedule showing service interval frequency.

2. PREVENTIVE MAINTENANCE PLAN AND SCHEDULE: Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

D. CORRECTIVE MAINTENANCE:

Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.

1. TROUBLESHOOTING GUIDES AND DIAGNOSTIC TECHNIQUES: Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

2. WIRING DIAGRAMS AND CONTROL DIAGRAMS: Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.

3. MAINTENANCE AND REPAIR PROCEDURES: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.

4. REMOVAL AND REPLACEMENT INSTRUCTIONS: Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of test and illustrations.

5. SPARE PARTS AND SUPPLY LISTS: Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonably delays. Special consideration is required for

facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.

6. CORRECTIVE MAINTENANCE MANHOURS: Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

E. APPENDICES:

1. The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment.

a. PARTS IDENTIFICATION: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

b. WARRANTY INFORMATION: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.

c. PERSONNEL TRAINING REQUIREMENTS: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

d. TESTING EQUIPMENT AND SPECIAL TOOL INFORMATION: Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

e. CONTRACTOR INFORMATION: Provide a list that includes the name, address, and telephone number of the General Contractor and each Subcontractor who installed the product or equipment, or system. For each item, also provide the name, address, and telephone number of the manufacturer’s representative and service organization most convenient to the project site. Provide the name, address, and telephone number of the product, equipment, and system manufacturers.

PART 3 – EXECUTION

3.01 TRANSMITTAL PROCEDURE

A. Unless otherwise specified, O&M manuals, information, and data shall be submitted as follows:

1. Submit one draft copy of completed volumes 30 days prior to final walk through. This copy will be reviewed and returned after final inspection, with Engineer comments. Only complete sets of O&M instructions will be reviewed for acceptance. Revise content of all document sets as required prior to final submission.

2. Submit five (confirm with Owner and Engineer final number required prior to submittal) hard copies of revised final volumes and one electronic PDF copy within ten days of conducting the final walk through.

3. Hard copies shall be submitted in commercial quality, durable, D-ring binders.

B. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment number as it appears in the project manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the project manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information.

C. If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

END OF SECTION

INDEX TO

SECTION 01 78 25

PLANT TESTING, STARTUP, AND COMMISSIONING

SECTION 01 78 25

PLANT TESTING, STARTUP, AND COMMISSIONING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Provide planning, functional completion testing, startup and commissioning as indicated and specifies. Section includes:

1. Plant Checkout Plan.
2. Functional Completion Testing.
3. Startup.
4. Commissioning.
5. Performance Testing.

1.02 REFERENCES

A. American National Standards Institute (ANSI):

1. B31.1: Power Piping Code.

B. American Water Works Association (AWWA):

1. C600: Installation of Ductile-Iron Water Mains and Their Appurtenances.

1.03 DEFINITIONS

A. The Plant Checkout Plan (the Plan) incorporates all aspects of functional completion testing, startup, commissioning, performance testing, training, and reliability tests to ensure the facility operates properly and meets deign intent and performance.

B. Functional Completion Testing is testing of the equipment and unit process systems to confirm that construction and installation has been completed in anticipation of initial startup of the equipment and unit process systems. Functional Completion Testing includes:

1. Physical Checkout shall be defined as the process of physically inspecting products after they have been installed in the Work to determine if the Products have been properly and completely installed, and are ready for startup.
2. Functional Completion Testing shall be defined as testing that is performed by the Contractor, with Supplier or Manufacturer assistance, on Products

after they have been installed in the Work, and after the performance of physical checkout, for the purpose of proving that the tested Products meet the requirements of the pertinent technical specifications. Administrative, test criteria, and minimum technical requirements for field testing are specified in Paragraph 1.08 of this Section.

C. Startup (clean water) shall be defined as the operation of equipment or unit process systems using clean water, air, or other fluids and gases as necessary to demonstrate the operation of the equipment or unit process systems with other equipment that is a part of, or a treatment process for the Facility. Administrative and minimum technical requirements for startup are specified in Paragraph 1.09 if this Section (24 hours minimum, generally three to four days).

D. Commissioning shall be defined as the operation of equipment of unit process systems using wastewater, process liquids or process solids, plant support equipment, and plant utilities to demonstrate equipment or unit process systems are capable of processing water or wastewater at specified flows and conditions for a sustained period of operation as required by this section or equipment or unit process systems are ready to begin Performance Testing. Administrative and minimum technical requirements for Commissioning are specified in Paragraph 1.10 of this Section (fourteen days minimum).

E. Performance Testing is defined as a test to demonstrate the specified throughout of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum compliance with the equipment or unit process systems performance requirements and guarantees (seven days).

F. The Testing and Startup Coordinator shall be defined as the person provided by the Contractor to coordinate and oversee the total spectrum of testing and inspection activities required by the Contract Documents. The Testing and Startup Coordinator shall have been in responsible charge of at least two similar Projects in the last four years.

G. Startup coordinator shall be the primary contact to execute the Plant check out plan.

1.04 ROLES AND RESPONSIBILITES

A. The Contractor shall provide all outside services, materials, labor, supplies, test equipment and other items necessary to perform the Testing, Startup and Commissioning specified herein. In addition, the Contractor shall arrange for and provide the participation or assistance of survey crews, quality control technicians, Supplier's representative(s), and required governmental agency representatives, as necessary.

B. The Contractor shall provide the services of the Supplier's or Manufacturer's representative(s) as follows:

1. Assistance during installation and field testing as specified in PART 3 of the specifications.

2. Startup.

3. Commissioning.

C. The Supplier's representative's activities required by this Section are in addition to the requirements for vendor training and other services specified elsewhere in the Contract Documents. Timing for the performance of these services is to be defined in the Contractors Plant Checkout Plan.

D. The Engineer will review and comment on the Contractor's deliverables, observe the physical activities, the shop and field testing, witness functional testing, and maintain the permanent record of all testing results, and provide verification of conformance to the specifications. The Engineer's right to review work, witness tests or monitor or assess the Work and activities does not relieve the Contractor of its obligation to comply with the requirements of the Contract Documents nor does it imply completion of the Work.

1.05 SUBMITTALS

A. Submit the following shop drawings.

1. Submit a Plant Checkout Plan for the facility, with a listing of tests, activities, and an associated timeline.

B. Qualification Data:

1. Submit resumes for each team member proposed for testing, startup, and commissioning.

a. Include a minimum of three startup and commissioning references including: project name, project location, contact person's name, contact person's telephone number, contact persons role during the project, dates of startup, and commissioning.

1.06 QUALITY ASSURANCE

A. Preparation of the plant checkout plan, functional completion testing, and startup and commissioning shall be performed by personnel:

1. Trained and experienced in O&M of the described equipment.

2. Familiar with the treatment or unit process.

1.07 PLANT CHECKOUT PLAN

A. The Contractor shall be responsible for preparing, coordinating, and executing the Plan.

1. The Contractor shall use the resources of the equipment and unit process systems suppliers in this work, particularly for specific equipment and unit process systems.

2. An initial draft of the Plan shall be submitted as indicated here:

   a. The initial draft of the Plant Checkout Plan shall be completed and submitted by the Contractor to the Engineer for review. The Engineer will require at least 15 days to review the submittal and return with any comments.

   b. The Contractor shall incorporate the Engineer's comments into the revised Plan within 15 days of the receiving comments, and reissue the Plan to the Engineer and Owner.

   c. The Contractor shall regularly schedule meetings with the Engineer and Owner to review and coordinate activities required by the Plan.

B. The Contractor shall provide a dedicated field staff to support the Plan activities. A Startup Coordinator shall be responsible for day to day activities and shall be the primary contact with the Engineer regarding Plan activities. Support staff shall include but not limited to designated mechanical, electrical and instrumentation and control engineers and technicians, and operating staff.

   1. The Contractor may require assistance from the Owner's operating and maintenance staff in commissioning and performance testing activities specified herein.

      a. The Contractor may require use of Owner's operating maintenance staff in performance testing activities, at the convenience of the Owner.

      b. These activities shall be incorporated in the Plan in defining responsibilities of the Plan participants.

C. The Plant Checkout Plan shall define:

   1. The logical and systematic performance of physical inspections, field and functional test, startup, commissioning, and performance testing including:

      a. A chronological schedule of all testing and inspection activities.

      b. A checklist of all inspection and testing activities broken down by location, discipline, system, and device or item.

      c. All blank forms proposed by the Contractor for verification or recording of the functional completion testing, startup, commissioning and performance testing.

      d. An index which cross references the forms to their intended application(s).

      e. A list of all suppliers' certifications, including those required by the applicable technical specifications. Provisions shall also be included for retesting, in the event it is required.

2. A list of participants in functional completion testing, startup, commissioning, and subsequent performance testing.

3. A list of special test equipment required for functional testing, startup, commissioning, and performance testing.

4. Sources of the test media (wastewater, water, power, air, etc.) for functional completion testing.

5. The proposed method of delivery of the media to the equipment to be tested during functional completion testing, startup, commissioning, and performance testing.

6. Temporary or interim connections for the sequencing of multiple units during functional completion testing, startup, commissioning, and performance testing.

7. Ultimate disposal of the test media after functional completion testing, startup, commissioning, and performance testing.

D. The Plant checkout plan shall be reviewed by the Engineer and Owner, modified or revised as necessary by the Contractor, then re-reviewed by the Engineer. The Contractor shall continue to update the Plan, working in conjunction with the Engineer and Owner, prior to the start of the scheduled equipment checkout. Each specific element of the plan must receive review or comment by the Owner, two weeks prior to the actual commencement of testing as defined herein.

E. The Contactor shall designate, in the Plan, a Startup Coordinator, to coordinate and manage the activities defined in the Plan.

1.08 FUNCTIONAL COMPLETION TESTING

A. Functional Completion Testing shall be completed as construction and installation of equipment is completed to demonstrate that the equipment is ready for equipment and unit process systems startup.

1. Functional Completion Testing shall be done in coordinated manner based on the Plant Checkout Plan prepared by the Contractor.

   a. The Owner's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.

   b. Additional witnesses, such as the Engineer, may be present to represent the Owner.

2. Functional Completion Testing procedures and documentation forms shall be developed by the Contractor. The procedures shall include a listing of items inspected for Functional Completion Testing.

3. In any equipment or unit process systems do not meet Functional Completion Testing requirements, it shall be the responsibility of the

Contractor and equipment suppliers to make the necessary corrections or replacements and repeat the test.

4. The equipment and unit process systems shall not be started up or put into service until the Functional Completion Testing is completed as evidenced by a completed Functional Completion Testing certificate for the equipment or subsystem.

5. Modifications to the equipment and unit process systems required to Functional Completion Testing requirements shall be provided, and all retesting shall be performed at no additional cost to Owner.

6. A Functional Completion Testing Certificate or recording form shall be prepared by the Contractor for each piece of equipment or unit process and submitted to the Engineer and Owner for review.

1.09 STARTUP

A. Startup activities for the Facility shall not be initiated until the Functional Completion Testing are satisfactorily completed for the equipment or unit process systems.

B. The requirements of this section shall be satisfactorily completed prior to beginning Commissioning for the equipment and unit process systems.

C. The Contractor shall be responsible for startup.

1. The Owner's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.

2. Additional witnesses, such as the Engineer, may be present to represent the Owner.

D. For equipment or unit process systems that do not meet the specified Startup requirements, it shall be the responsibility of the Contractor and equipment or unit process systems suppliers to make the necessary corrections or replacements and repeat Startup at no additional cost to the Owner.

E. Startup Reports for each piece of equipment or unit process shall be completed and submitted by the Contractor to the Engineer and Owner.

F. The Contractor shall not begin Commissioning until Startup certificate is completed and is submitted.

1.10 COMMISSIONING

A. Commissioning activities for the Facility shall not be initiated until the requirements of Startup are completed for the equipment or unit process systems.

B. The requirements of this section shall be satisfactorily completed prior to beginning Performance Testing for equipment and unit process systems.

C. Commissioning shall be used by the Contractor and equipment or unit process suppliers to adjust, fine tune, modify, and prepare the equipment or system for continuous operation and Performance Testing.

1. Equipment shall not be operated without the guidance of qualified personnel having the knowledge and experience necessary to conduct proper operation thereof and obtain valid results.

2. All required adjustments, test, operation checks, and Startup and Commissioning activities shall be provided by qualified personnel.

3. Contractor shall be responsible for planning, supervising, and executing the Startup and Commissioning of the equipment and unit process systems with the assistance of equipment or unit process systems suppliers in accordance with the Plan.

D. The Contractor shall be responsible for Commissioning under the direction of its Startup Coordinator.

1. The Owner's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.

2. Additional witnesses, such as the Engineer, may be present to represent the Owner.

E. For equipment or unit process systems that do not meet Commissioning requirements, it shall be the responsibility of the Contractor and equipment or unit process systems suppliers to make the necessary corrections or replacements and repeat Commissioning at no additional cost to the Owner.

F. The equipment or unit process systems shall not be Performance Tested or otherwise placed into service until Commissioning is completed as evidenced by a completed Commissioning certificate for the equipment or unit process systems.

G. Commissioning Certificates for each piece of equipment or unit process shall be completed and submitted by the Contractor to the Engineer and Owner.

1.11 PERFORMANCE TESTING

A. Performance Testing is defined as a test to demonstrate the specified throughout of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum complicate with the equipment or unit process systems performance requirements and guarantees (Seven days).

B. During the performance testing, daily equal volume composite samples from the influent and effluent shall be obtained by the Contractor (or Owner if contractor makes prior arrangements for the owner to assist).

C. These samples will be for the measurement of the following parameters by the contractor:
1. BOD.

2. TSS.
3. TKN.
4. NH3.
5. TP.
6. TN.
7. Flow.

D. The treated effluent shall meet these parameters:

Parameter	Effluent Limits
BOD	<5 mg/L
TSS	<5 mg/L
TKN	<13 mg/L
NH3	<2 mg/L
TP	<9mg/L
TN	<20 mg/L

1.12 OPERATING PERIOD

A. Operating period is defined as a 30 day period that the Owner operates the plant while the contractor provides personnel which are available to answer questions, address operational issues and equipment malfunctions and adjustments, and similar items during the initial operating period.

PART 2 – PRODUCTS

Not used

PART 3 – FDA EXECUTION

3.01 PLANT CHECKOUT PLAN

A. The Plan shall include the following items as a minimum:

1. Cover Sheet with Plant identification, title, date, and other information as needed to properly identify the specific information for the Facility.

2. Status and revisions sheet with appropriate dates and signatures spaces to document the development and status of the document.
3. Table of Contents including Appendix.

4. Equipment and systems descriptions with anticipated break down for individual startup activities. This section shall define the individual "packages" for startup activities for the equipment or unit process systems.

5. Schedule of events and other activities covered by the Plan.

   a. The schedule shall define dates for completing activities for equipment and unit process systems.

b. The schedule shall be the Contactor's best estimate of time sequence at the time of issuance.

c. The Contractor shall submit schedule updates to the Plan as necessary and at least monthly.

d. The schedule shall follow the required sequencing as specified herein.

6. Sign-off sheets consisting of certification forms or completion reports required by the specifications shall be included in the Plan. Standard forms shall be developed by the Contractor for this purpose.

7. Reports, test results and other supporting data shall be collected by the Contractor for documentation of the specific details leading to the certification or completion.

B. Following shall be the sequence for completing functional completion testing, startup, commissioning, and performance testing activities required by the Plan.

1. Bongo Influent Screen.

2. MBR Process.

3. Odor Control Unit.

4. Chlorine Contact/Disinfector.

5. Sludge Dewatering.

6. Standby generator.

7. Effluent Pump Station and LAS System.

C. Any variation in the startup sequence deemed necessary by the Contractor shall be reviewed by the Engineer prior to changing the sequence.

3.02 FUNCTIONAL COMPLETION TESTING

A. Provide 15 working days written notice to the Engineer for each Functional Completion Test so that the Engineer my witness the functional completion tests. The Engineer may witness the performance of any or all Functional Completion Testing, at their option.

B. Testing shall be conducted in accordance with the accepted Plan using applicable standard techniques reviewed by the Engineer and Owner.

1. Local and remote instrumentation may be used to record test data where it is determined the devices have been calibrated and sufficient to obtain necessary data.

C. The Contractor shall develop standard data sheets to document Functional Completion Testing requirements have been met for all equipment and unit process systems included in the Plan.

1. As equipment testing is completed the appropriate data sheet shall be completed and signed by the responsible party and submitted to the Engineer for review and acceptance.

2. Data values shall be stated in the engineering units noted in the equipment specifications.

D. A detailed Functional Completion Test plan shall be prepared and submitted to the Engineer for review and comment as noted paragraph 1.08 above.

1. The plan shall be prepared by the Contractor in conjunction with the equipment or subsystem supplier and shall become a part of the overall Plan.

E. In the event no reference to procedures is made, or no procedures for startup and commissioning are contained in a technical specification for the following test parameters, the following shall be the checkout requirements. Should there requirements conflict with the Supplier's recommendations or in any way be less stringent that the Supplier's requirements, they shall be superseded by the Supplier's requirements for checkout testing.

1. Measurement of wearing ring clearances for all pumps requiring assembly, so equipped:

a. Take two readings taken opposed to each other by 90 degrees.

b. All measured clearances shall be within Supplier's specifications for new installation. Replace and recheck rings found to be out of round or out of specified tolerance.

2. Measure of Impeller Bore for all pumps requiring assembly:

a. Take two readings opposed to each other by 90 degrees.

b. All measured clearances shall be within Supplier's specifications for new installation. Replace and recheck impellers found to be out of round or out of specified tolerance.

3. Measurement of shaft runout for all rotating equipment requiring assembly:

a. Remove bearings from the shaft. Support shaft on pedestal rollers or in a lathe.

b. Check each shoulder on the shaft.

c. Take two readings for each shoulder, opposed to each other by 90 degrees.

d. All measured clearances shall be within Supplier's specifications for new installations. Replace and recheck shafts found to be out of round or out of specified tolerance.

4. Vibration Measurements:

a. Provide vibrational signature testing and documentation for each piece of direct drive or close coupled rotating equipment with a motor HP of 100 or above and a rated operating speed in excess of 1999 RPM.

b. Unless specified otherwise, the current edition of the Hydraulic Institute Standard, "Acceptable Field Vibration Limits" shall be the standard for vibrational testing.

c. Take all specified vibrational readings in three directions: vertical, horizontal, and axial.

d. Provide vibrational measurements in the following engineering units:

1. Displacement in thousandths of an inch (mils), peak to peak.

2. Velocity in inches per second (ips), peak to peak.

3. Acceleration in feet per second per second (lg=32.3 ft. /sec. /sec.) zero to peak.

4. Spike energy in g-SE.

5. The vibrational readings shall be less than the device rotating frequency, and within the operating band specified by the Supplier.

6. Amplitude Allowable Maximums:

RPM	Amplitude inches peak to peak:
3,000 and above	0.001
1,500 – 2,999	0.002
1,000 – 1,499	0.0025
999 and below	0.003

5. Belt Drivers:

   a. All belts shall ride within the sheave and not slip to the groove(s).

   b. Belt tension shall be in accordance with Supplier's recommendations.

   c. Pulley alignment shall be within Supplier's recommendations.

6. Gear Drives and Reducers:

   a. Check gears for lash at no less than three points around the gear.

   b. Rotate gears a full 360 degrees while checking alignment.

7. Coupling/Shaft Alignment:

   a. Perform all final alignments and checks with a dial indicator or a laser device. Feeler gauges and straight edges are not acceptable.

   b. Eliminate soft foot conditions prior to aligning.

   c. When checking for final soft foot, any displacement in excess of 0.002" must be corrected.

   d. When checking for pipe strain, any displacement in excess of 0.002 inches requires piping realignment.

   e. Alignments will not be regarded as final until the grout is set and all piping has been attached. Demonstrate that alignment is not changes by attachment of piping.

   f. Shim the driving element, never the driven element.

   g. Take bracket sag connections into account when using a dial indicator. Bracket sag shall be determined on a rigid pipe.

   h. Mount a dial indicator to the driven element so that it can be rotated. Rotate both elements while aligning.

   i. When aligning three coupled elements, align gear reduction elements with the driven element first, then align the driver to the gear reduction element.

   j. Check all four alignments, i.e., angular alignment in the vertical and horizontal planes and parallel alignment in the vertical and horizontal planes.

   k. The acceptable alignment accuracy for flexible couplings is +0.005 inches, or the Supplier's specifications, whichever is more stringent.

   l. The dial indicators must be perpendicular to the alignment surface.

m. Number hold down nuts prior to tightening. Loosen in reverse order. Tighten in ascending order.

n. Use only clean, deburred shims. Clean the machine base and feet from rust or burrs prior to alignment.

8. Measure of Noise (dBA):

a. Eliminating noise sources generated by adjacent construction activity prior to testing.

b. Establish a background noise level prior to testing.

c. Perform noise level testing on each installed device as required by the technical specifications.

d. The maximum noise level exposure is 65 dBA over eight hours continuous for office, shop, and other areas where the Owner's personnel will be performing their duties.

e. The maximum noise level at five feet from the generator shall be 65 dBA.

9. Hydrostatic Testing:

a. AWWA C600 standards latest edition are the standards for all hydrostatic testing.

b. Visually inspect all welds prior to testing, for cracks, undercut on surface greater than 1/32-inches deep, lack of fusion on surface, reinforcement greater than Table 127.4.2 located in ANSI B31.1 Power Piping, and incomplete penetration (when accessible). Repair or rework as directed by the Engineer.

c. At no time during hydrostatic testing shall any part of the piping system be subjected to a stress greater than 90 percent of its yield strength at test temperature.

d. After ten minutes of full hydrostatic test pressures, make an examination for leakage of all joints, connections, and all regions of high stress, such as around openings and thickness transition sections.

e. Unless otherwise specified, the minimum required hydrostatic test pressure shall be one and a half times the design pressure as specified or 150 psi minimum or as indicated.

F. Where required by the equipment specifications, the Contractor shall furnish an authorized, competent representative of the equipment or unit process supplier to supervise and coordinate the Functional Completion Testing program.

1. Instrument readings and other test data shall be tabulated by the Contractor.

G. Document Requirements:

1. Certificates are required for all Functional Completion Testing for equipment and unit process systems. Four copies of the completed certificates shall be supplied for review by the Engineer. Contents of the certificated shall be supplied for review by the Engineer. Contents of the certificate shall be at a minimum:

   a. Contractor Review Comments, and Approval Page. This page shall include Certification by the preparer that he or she is the person responsible for the test data and the data is authentic and accurate. This page shall include a listing and signature of all witnesses to the test.

   b. Equipment Suppliers Review Comments, and Approval Page. This page shall include Certification by the equipment or unit process systems suppliers that the equipment or unit process systems are properly installed and suitable for startup.

   c. Process, Equipment, and P&ID's involved in this Functional Completion Test.

   d. Schedule.

   e. Test Descriptions/Procedures.

      1. Equipment or unit process systems tested.

      2. Test dates.

      3. Electrical Inspection and Tests.

      4. Test results.

      5. Any repairs or corrections required to obtain acceptable test results.

      6. Calibration sheet for instrumentation or devices used for testing but not part of plant installation.

      7. Copies of calibration records for plant installed instrumentation.

   f. Certify Mechanic and Installation. Inspection and certification to be conducted by equipment representative. Inspect and certify that each piece of equipment meets the following requirements:

      1. Not damaged in transportation or installation.

2. Properly installed with no undue force imposed from piping or supports.

3. Is properly lubricated.

4. Motor rotation is correct.

5. Free of overheating.

6. Free of vibration.

7. Free of noise.

8. Functions without overloading.

9. Piping and other connections are completed.

10. No leaks at equipment connections (static pressure testing).

g. Certify Electric Calve Mechanics and Installation.

h. Inspect and certify that each valve meets the following requirements:

1. Not damaged in transportation or installation.

2. Properly installed with no undue force imposed from piping or supports.

3. Is properly lubricated.

4. Motor rotation is correct.

5. Free of overheating.

6. Free of vibration.

7. Free of noise.

8. Functions without overloading.

9. Piping and other connections are completed.

10. No leaks at equipment connections (static pressure testing).

i. Instrumentation and Control Inspection and Test.

2. Tests certificates shall be submitted no later than 30 calendar days, after testing ends. The Engineer and Owner shall have no more than 30 calendar days to complete a review and return with exceptions noted.

3.03 STARTUP

A. Provide 15 days written notice to the Engineer for each startup procedure so that the Engineer may witness the each startup procedure. The Engineer may witness the performance of any or all each startup procedure, at their option.

B. Startup shall begin at the conclusion of Functional Completion Testing, when the equipment or unit process systems are subject to full operation using a process flow substitute.

1. Startup activities shall be carried out to show the equipment and unit process systems are functional.

2. The various vendors, equipment suppliers and manufacturers shall provide on-site supervision and assistance for Startup services for the new facility.

C. The Contractor shall coordinate all startup activities for equipment and unit process systems in accordance with the accepted Plan. The Contractor shall develop a detailed Startup plan as part of that Plan that includes the following as a minimum:

1. Description of the overall, general startup process.

2. List of equipment and unit process systems included for Startup activities.

3. Detailed startup sequence of activities.

4. Equipment and system boundaries as shown using marked-up P&IDs.

5. Listing of staff and responsibilities for activities.

D. Startup Requirements: The following are minimum requirements for completion of Startup activities:

1. Startup shall show that the equipment or unit process systems are suitable for continuous operation.

a. Startup shall also demonstrate that local and remote instrumentation and controls are functioning properly and communicating with each other properly.

b. Equipment or unit processes shall be operated for a minimum of 24 hours without interruptions in service.

c. If the startup fails, the contractor will be responsible for redoing the startup testing at no additional costs to the Owner.

E. Document Requirements

1. A Startup certificate shall be prepared and submitted to the Engineer for review and returned with any exceptions noted. The reports shall include, but not be limited to, the following:

a. Contractor Review Comments and Approval Page. This page shall include Certification by the preparer that he/she is the person responsible for the test data and the data is authentic and accurate. This page shall include a listing and signature of all witness's to the test. Certification by the Contractor that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance; and that the equipment or unit process systems are suitable for Commissioning.

b. Equipment Suppliers Review Comments and Approval Page. This page shall include Certification by the equipment or unit process systems suppliers that the equipment or unit proves systems have been started up properly and operated within the design parameters. Certification by the equipment or unit process systems supplier that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance; and that the equipment or unit process systems are suitable for Commissioning.

c. Engineer Review Comments, and Approval Page.

d. Process, Equipment, and P&IDs Involved in this startup test.

e. Startup Schedule.

f. Test Description and Procedures.

    1. Equipment or unit process systems tested.

    2. Test dates.

    3. Electrical Inspection and Tests.

    4. Test results.

    5. Any repairs or corrections required to obtain acceptable test results.

    6. Calibration sheet for instrumentation or devices used for testing but not part of plant installation.

g. Appendix:

    1. A summary of all data used in the calculations, including source, and formulas with all terms defined.

    2. Calculations for all data submitted, fully defined.

3. Copies of all raw field data sheets, including those indicating sampling point locations, and notes.

4. Production and operational data.

5. Calibration procedures and work sheets for sampling equipment.

6. Copies of calibration records for instrumentation.

3.04 COMMISSIONING

A. Provide 15 working days written notice to the Engineer for each commissioning procedure so that the Engineer may witness the each commissioning procedure. The Engineer may witness the performance of any or all each commissioning procedure, at their option.

B. Commissioning shall begin at the conclusion of Startup Testing, wherein the equipment or unit process systems are subjected to full operation using the process flows.

1. On successful completion of Startup, process flows and solids shall be used for commissioning the equipment and unit process systems to show the equipment and unit process systems function properly. Commissioning shall confirm the proper operation of the equipment and unit process systems with process fluids and process solids, adjustments shall be made, and the equipment or unit process systems shall be optimized and brought into compliance with design criteria.

2. The various vendors, equipment suppliers and manufacturers shall provide on-site supervision and assistance for Commissioning services for the new facility.

C. The Contractor shall coordinate all Commissioning activities for equipment and unit process systems in accordance with the accepted Plan. The Contractor shall develop a detailed Commissioning plan as part of that Plan that includes the following as a minimum:

1. Description of the overall, general Commissioning process.

2. List of equipment and unit process systems included for Commissioning activities.

3. Detailed Commissioning sequence of activities.

4. Equipment and system boundaries as shown using marked-up P&IDs.

5. Listing of staff and responsibilities for activities.

D. Commissioning Requirements: The following are minimum requirements for completion of Commissioning activities:

1. Commissioning shall show that the equipment and unit process systems are capable of continuous operation using process liquids and solids, chemicals, and utilities; and that the flows, wastewater, operating parameters, and performance requirements have been demonstrated for a minimum of seven days of continuous operation, or the period required in the equipment specifications, whichever is longer.

    a. Shutdowns that occur because of power outages, acts of God, or failure of support systems not part of this contract will not be a cause of failure of the seven days of continuous operation.

2. If the commissioning fails, the contractor will be responsible for redoing the commissioning at no additional cost to the Owner.

E. Documentation Requirements:

1. A Commissioning report shall be prepared and submitted to the Engineer for review and retuned with any exceptions noted. The reports shall include, but not be limited to, the following:

    a. Contractor Review Comments and Approval Page. This page shall include Certification by the preparer that he or she is the person responsible for the test data and the data is authentic and accurate. This page shall include a listing and signature of all witness's to the test. Certification by the Contractor that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance; and that the equipment or unit process systems are suitable for Performance Testing.

    b. Equipment Suppliers Review Comments and Approval Page. This page shall include Certification by the equipment or unit process systems suppliers that the equipment or unit proves systems have been started up properly and operated within the design parameters. Certification by the equipment or unit process systems supplier that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance; and that the equipment or unit process systems are suitable for Performance Testing.

    c. Engineer Review Comments, and Approval Page.

    d. Process, Equipment, and P&IDs Involved in this startup commissioning test.

    e. Commissioning Schedule.

    f. Test Description and Procedures.

1. Equipment or unit process systems tested.

2. Test dates.

3. Electrical Inspection and Tests.

4. Test results.

5. Any repairs or corrections required to obtain acceptable test results.

6. Calibration sheet for instrumentation or devices used for testing but not part of plant installation.

g. Appendix:

1. A summary of all data used in the calculations, including source, formulas with all terms defined.

2. Calculations for all data submitted, fully defined.

3. Copies of all raw field data sheets, including those indicating sampling point locations, and notes.

4. Production and/or operational data.

5. Calibration procedures and work sheets for sampling equipment.

6. Copies of calibration records for instrumentation.

F. Commissioning Documentation and Reports

3.05 PERFORMANCE TESTING

A. Begin a seven day Performance Test after successful commissioning and approval by regulatory agencies including, but not limited to SCDHEC.

END OF SECTION

INDEX TO

SECTION 01 78 33

BONDS

SECTION 01 78 33

BONDS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Preparation and submittal of bonds.

B. Time and schedule of submittals.

1.02 RELATED SECTIONS

A. Document 00 11 16 – Invitation to Bid: 00 21 13 – Instruction to Bidders.

B. Document General Conditions – EJCDC: Performance bond and labor and material payment bonds.

C. Section 01 77 00 –Closeout Procedures: Contract closeout procedures.

D. Section 01 78 23 – Operation and Maintenance Data.

E. Individual Specifications Sections: Bonds required for specific Products or Work.

1.03 FORM OF SUBMITTALS

A. Bind in commercial quality 8–1/2 x 11 appropriately sized, D-ring binders with durable covers.

B. Cover: Identify each binder with typed or printed title BONDS with title of Project; name, address, and telephone number of Contractor and equipment supplier; and name of responsible company principal.

C. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of Product or work item.

D. Separate each bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

E. Provide a summery sheet of all bonds.

1.04 PREPARATION OF SUBMITTALS

A. Obtain bonds executed by responsible Subcontractors, suppliers, and manufacturers, in accordance with timeframes listed herein.

B. Verify documents are in proper form, contain full information, and are notarized.

C. Co–execute submittals when required.

D. Retain bonds until time specified for submittal.

1.05 TIME OF SUBMITTALS

A. For equipment or components of equipment put into service during construction with Owner's permission, submit documents within ten days of Owner's acceptance.

B. Make other submittals within ten days of date of final acceptance of the item or Work, prior to final Application for Payment.

C. For items or Work for which acceptance is delayed beyond date of final completion, submit within ten days of acceptance, listing the date of acceptance as the beginning of the bond period.

END OF SECTION

INDEX TO

SECTION 01 78 36

WARRANTIES

SECTION 01 78 36

WARRANTIES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Preparation and submittal of warranties.

B. Time and schedule of submittals.

1.02 RELATED SECTIONS

A. General Conditions – EJCDC: Warranties and correction of work.

B. Section 01 77 00 – Closeout Procedures: Contract closeout procedures.

C. Section 01 78 23 – Operation and Maintenance Data.

D. Individual Specifications Sections: Warranties required for specific Products or Work.

1.03 FORM OF SUBMITTALS

A. Bind in commercial quality 8–1/2 x 11, appropriately sized, D- ring binders with durable covers.

B. Cover: Identify each binder with typed or printed title WARRANTIES with title of Project; name, address, and telephone number of Contractor and equipment supplier; and name of responsible company principal.

C. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual. Identify each item with the name of Product or work item and the number and title of the specification section in which it is specified.

D. Separate each warranty with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

E. Provide a summery sheet of all warranties.

1.04 PREPARATION OF SUBMITTALS

A. Obtain bonds executed by responsible Subcontractors, suppliers, and manufacturers, in accordance with timeframes listed herein.

B. Verify documents are in proper form, contain full information, and are notarized.

C. Co–execute submittals when required.

D. Retain warranties until time specified for submittal.

1.05 TIME OF SUBMITTALS

A. For equipment or components of equipment put into service during construction with Owner's permission, submit documents within ten days of Owner's acceptance.

B. Make other submittals within ten days of date of final acceptance of the item or Work, prior to final Application for Payment.

C. For items or Work for which acceptance is delayed beyond date of final completion, submit within ten days of acceptance, listing the date of acceptance as the beginning of the warranty period.

END OF SECTION

INDEX TO

SECTION 01 79 00

DEMONSTRATING AND TRAINING

SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specifications, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for instructing utilities personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.

2. Training in operation and maintenance of systems, subsystems, and equipment.

1.03 INFORMATION SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' name for each training module. Include outline for each training module.

B. Qualification Data: For instructor, demonstrating qualifications and ability to instruct on maintenance and care of system, equipment, and products.

C. Schedule of Demonstration and Training: Prepare a schedule in tabular form of all demonstration and training required in individual Specification Sections including:

1. Specification Section number and title.

2. Description of required demonstration and training.

D. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.04 QUALITY ASSURANCE

A. Instructor Qualifications: A factory-authorized service representative, experienced in operation and maintenance procedures and training. Manufacturer's sales staff is not acceptable.

B. Pre-instruction Conference: Conduct conference at Project site to review methods and procedures related to demonstration and training.

PART 2 – PRODUCTS

2.01 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Provide trainee manuals.

C. Training Modules: For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Including the following:

   a. System, subsystem, and equipment descriptions.

   b. Operating standards.

   c. Regulatory requirements.

   d. Equipment function.

   e. Operating characteristics.

   f. Limiting conditions.

   g. Performance curves.

2. Documentation: Review the following items in detail:

   a. Emergency manuals.

   b. Operations manuals.

   c. Maintenance manuals.

   d. Project record documents.

   e. Identification systems.

   f. Warranties and bonds.

   g. Maintenance service agreement and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

   a. Instructions on meaning of warnings, trouble indications, and error messages.

b. Instructions on stopping.

c. Shutdown instructions for each type of emergency.

d. Operating instructions for conditions outside of normal operating limits.

e. Sequences for electric or electronic systems.

f. Special operating instructions and procedures.

g. A tour of the installation identifying the location of all system components.

4. Operations: Include the following, as applicable:

a. Startup procedures.

b. Equipment or system break-in procedures.

c. Routine and normal operating instructions.

d. Regulation and control procedures.

e. Control sequences.

f. Safety procedures.

g. Instructions on stopping.

h. Normal shutdown instructions.

i. Operating procedures for emergencies.

j. Operating procedures for system, subsystem, or equipment failure.

k. Seasonal and weekend operating instructions.

l. Required sequences for electric or electronic systems.

m. Special operating instructions and procedures.

n. Sequence of operation.

5. Adjustments: Include the following:

a. Alignments.

b. Checking adjustments.

c. Noise and vibration adjustments.

d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

   a. Diagnostic instructions.

   b. Testing and inspection procedures.

7. Maintenance: Include the following:

   a. Inspection of procedures.

   b. Types of cleaning agents to be used and methods of cleaning.

   c. List of cleaning agents and methods of cleaning detrimental to product.

   d. Procedures for routine cleaning.

   e. Procedures for preventative maintenance.

   f. Procedures for routine maintenance.

   g. Instruction on use of special tools.

8. Repairs: Include the following:

   a. Diagnosis instructions.

   b. Repair instructions.

   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.

   d. Instructions for identifying parts and components.

   e. Review of spare parts needed for operation and maintenance.

   f. Product support/service model.

   g. Purchasing of replacement parts.

9. Instruction specific to Instrumentation and Controls, Electrical, Lighting Controls, or any other new technology that is integrated with another system: Include the following:

   a. Overview and theory.

   b. Wiring diagrams, including the one line diagram.

   c. Graphics packages and touch screens for the system.

d. Alarms and diagnostics.

e. Reporting functions dynamically and historically.

f. Remote access to the system.

g. Database back-up and maintenance.

h. Replacement and re-programming of replacement parts.

i. Programming.

j. Help files and other troubleshooting documentation.

D. Operation and Maintenance Manuals: Provide appropriate Operation and Maintenance manuals in each training session so that the detail drawings and maintenance activates are outlined and discussed for each application.

PART 3 - EXECUTION

3.01 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module.

B. Set up instructional equipment at instruction location.

3.02 INSTRUCTION

A. Engage qualified instructors to instruct personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Coordinate schedule for all training with Engineer and provide the following:

a. Minimum three weeks notification.

b. Training matrix in calendar format.

c. Training outline for each session.

2. Do not schedule until equipment has been started up, commissioned, and is currently operating in its normal condition.

3. Do not schedule overlapping training sessions.

4. Schedule training sessions for a maximum of four hours per day; afternoons preferred.

5. Provide separate training session on each system for operational/maintenance groups and user groups.

6. Training sessions will be cancelled and rescheduled unless the following documentation is received:

   a. Instruction qualifications.

   b. Evidence that equipment has been started up, commissioned, and is currently operating in its normal condition.

   c. Operation and Maintenance manuals.

C. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION

INDEX TO

SECTION 01 79 01

EQUIPMENT AND SYSTEM
PERFORMANCE AND OPERATIONAL TESTING

SECTION 01 79 01

EQUIPMENT AND SYSTEM PERFORMANCE AND OPERATIONAL TESTING

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section contains requirements for the Contractor's performance in documenting testing work required under this contract. In addition, this section contains requirements the for the Contractor's performance during installed performance testing of all mechanical, electrical, instrumentation, and HVAC equipment and systems, including structures for watertight construction, provided under this. This section supplements but does not supersede specific testing requirements found elsewhere in this project manual.

B. After equipment has been shown thru functional completion testing to be ready for equipment and process start up, the following outline applies for the MBR process.

1. Startup (clean water testing) is defined as the operation of equipment or unit process systems using clean water, air, or other fluids and gases as necessary to demonstrate the operation of the equipment or unit process systems with other equipment that is a part of or a treatment process for the Facility. (24 hours min. generally 3-4 days)

2. Commissioning is defined as the operation of equipment of unit process systems using wastewater, process liquids or process solids, plant support equipment, and plant utilities to demonstrate equipment or unit process systems are capable of processing water or wastewater at specified flows and conditions for a sustained period of operation as required by this section or equipment or unit process systems are ready to begin Performance Testing. (14 days min.)

3. Performance Testing is defined as a test to demonstrate the specified throughout of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum compliance with the equipment or unit process systems performance requirements and guarantees. (7 days)

4. During the performance testing, daily equal volume composite samples from the influent and effluent shall be obtained by the Contractor (or Owner if contractor makes prior arrangements for the owner to assist).

5. These samples will be for the measurement of the following parameters by the contractor:
   a. BOD
   b. TSS
   c. TKN
   d. NH3
   e. TP
   f. TN
   g. Flow

6. The treated effluent shall meet these parameters:
   a.
   b. Parameter Effluent Limits
   c. BOD <5 mg/L
   d. TSS <5 mg/L
   e. TKN <13 mg/L
   f. NH3 <2 mg/L
   g. TP <9 mg/L
   h. TN <20 mg/L

7. Operating period: is defined as a 30 day period that the Owner operates the plant while the contractor provides personnel which are available to answer questions, address operational issues and/or equipment malfunctions/adjustments and similar items during the initial operating period.

C. Performance Testing shall be completed for items of equipment and unit process systems to confirm that the equipment or unit process systems meet the Guaranteed Performance Criteria and the equipment and unit process systems performance criteria specified for the equipment or unit process. Performance Testing shall include testing requires by regulatory agencies or environmental regulations. Performance Testing shall be performed to demonstrate the specified throughput of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum compliance with the equipment or unit process systems performance requirements and guarantees.

D. The information collected shall be used as a basis for determining acceptability of the equipment or unit process systems to meet performance requirements.

E. If any of the equipment or unit process systems fail to meet the specified requirements and guarantees, it shall be the responsibility of the Contractor and equipment suppliers to make the necessary corrections or replacements and repeat the test. This procedure shall be followed until all equipment meets the guaranteed performance requirements and has been accepted by the Engineer.

F. All modifications required to meet performance criteria, and all retesting shall be performed at no additional cost to the Owner. This includes

payment of all engineering fees and expenses associated with the Owner's Consultant's observation of the retest.

G. Corrective work resulting from failed performance shall be immediately scheduled and work shall commence within one week unless there is supportable proof that this is impossible. In that case, the Contractor shall request in writing an extension of time indicating the exact time the corrective work will begin.

H. In the event that the equipment of unit process systems do not meet pass/fail criteria of the Performance Guarantees within the extension period stipulated in the Contract, the Engineer shall determine acceptance per the provisions included in the Contract.

1.02 QUALITY ASSURANCE

A. CONTRACTOR'S QUALITY ASSURANCE MANAGER:

1. The Contractor shall appoint an operations engineer or equally qualified operations specialist as Quality Assurance Manager to manage, coordinate, and supervise the Contractor's quality assurance program. The Quality Assurance Manager shall have at least five years of total experience, or experience on at least five separate projects, in managing the startup commissioning of mechanical, electrical, instrumentation, HVAC, process, piping systems, and MBR systems. The quality assurance program shall include:

a. A testing plan setting forth the sequence in which all testing work required under this project manual will be implemented.

b. A documentation program to record the results of all equipment and system tests.

c. An installed performance testing program for all piping, mechanical, electrical, instrumentation, and HVAC equipment and systems installed under this contract.

d. A calibration program for all instruments, meters, monitors, gages, and thermometers installed under this contract.

e. A calibration program for all instruments, gages, meters, and thermometers used for determining the performance of equipment and systems installed under this contract.

f. A testing schedule conforming to the requirements specified in paragraph 01 79 01-2.02 C.

1. For the purposes of this section, a system shall include all items of equipment, devices and appurtenances connected in such a fashion as

their operation or function complements, protects or controls the operation or function of the others. The Quality Assurance Manager shall coordinate the activities of all subcontractors and suppliers to implement the requirements of this section.

B. CALIBRATION:

1. All test equipment (gages, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this contract shall be calibrated to within plus or minus two percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale. Pressure gages shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.

2. Liquid flow meters, including all open channel flow meters and all meters installed in pipelines with diameters greater than two inches shall be calibrated in situ using either the total count or dye dilution methods. Gas flow meters installed in piping systems with diameters greater than six inches shall be calibrated in situ using the pitot tube velocity averaging method. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than ten percent to at least 75 percent of system full scale. At least five confirmed valid data points shall be obtained within this range. Confirmed data points shall be validated by not less than three test runs with results which agree within plus or minus two percent.

C. REFERENCES:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document

before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/ASME B40.1	Gauges Pressure Indicating Dial Type—Elastic Element
ASTM E77	Method for Verification and Calibration of Liquid-in-Glass Thermometers
ASHRAE 41.8	Standard Methods of Measurement of Flow of Gas
Dye Dilution Calibration Method	Flow Measurements in Sanitary Sewers By Dye Dilution, Turner Designs Mountain View, California,
	Flow Measurement in Sewer Lines by the Dye Dilution Method, Journal of the Water Pollution Control Federation, Vol. 55, Number 5, May, 1983, pg. 531
	Flow Measurement in Open Channels and Closed Conduits, Vol 1, U.S. Department of Commerce, National Bureau of Standards, pg. 361
	Techniques of Water-Resources Investigations of the United States Geological Survey, Chapter 16, Measurement of Discharge Using Tracers

1.03 SUBMITTALS

A. Submittal shall consist of the following:

1. A complete description of the Contractor's plan for documenting the results from the test program in conformance with the requirements of paragraph 01 79 01-2.02 A, including:

   a. Proposed plan for documenting the calibration of all test instruments.

   b. Proposed plan for calibration of all instrument systems, including flow meters and all temperature, pressure, weight, and analysis systems.

   c. Sample forms for documenting the results of field pressure and performance tests.

2. The credentials and certification of the testing laboratory proposed by the Contractor for calibration of all test equipment.

3. Preoperational check-out procedures, reviewed and approved by the respective equipment manufacturers.

4. Detailed testing plans, setting forth step-by-step descriptions of the procedures proposed by the Contractor for the systematic testing of all equipment and systems installed under this contract.

5. A schedule and subsequent updates, presenting the Contractor's plan for testing the equipment and systems installed under this contract.

6. A schedule establishing the expected time period (calendar dates) when the Contractor plans to commence operational testing of the completed systems, along with a description of the temporary systems and installations planned to allow operational testing to take place.

7. A summary of the Quality Assurance Manager's qualifications, showing conformance to paragraph 01 79 01-1.02 A requirements.

PART 2 – PRODUCTS

2.01 GENERAL

A. The Contractor shall prepare test plans and documentation plans as specified in the following paragraphs. The Engineer will not witness any test work for the purpose of acceptance until all test documentation and calibration plans and the specified system or equipment test plans have been submitted and accepted.

2.02 DOCUMENTATION

A. DOCUMENTATION PLANS:

1. The Contractor shall develop a records keeping system to document compliance with the requirements of this Section. Calibration documentation shall include identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory.

2. Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test, and signature spaces for the Engineer's witness and the Contractor's quality assurance manager. A separate file shall be established for each system and item of equipment. These files shall include the following information as a minimum:

   a. Metallurgical tests
   b. Factory performance tests
   c. Accelerometer recordings made during shipment

d. Field calibration tests[1]
e. Field pressure tests[1]
f. Field performance tests[1]
g. Field operational tests[1]

3. Section 01 99 90 contains samples showing the format and level of detail required for the documentation forms. The Contractor is advised that these are samples only and are not specific to this project nor to any item of equipment or system to be installed under this contract. The Contractor shall develop test documentation forms specific to each item of equipment and system installed under this contract. Acceptable documentation forms for all systems and items of equipment shall be produced for review by the Engineer as a condition precedent to the Contractor's receipt of progress payments in excess of 50 percent of the contract amount. Once the Engineer has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce sufficient forms, at his expense, to provide documentation of all testing work to be conducted as a part of this contract.

B. TEST PLANS:

1. The Contractor shall develop test plans detailing the coordinated, sequential testing of each item of equipment and system installed under this contract. Each test plan shall be specific to the item of equipment or system to be tested. Test plans shall identify by specific equipment or tag number. Each device or control station to be manipulated or observed during the test procedure, and the specific results to be observed or obtained. Test plans shall also be specific as to support systems required to complete the test work, temporary systems required during the test work, subcontractors' and manufacturers' representatives to be present and expected test duration. As a minimum, the test plans shall include the following features:

a. Step-by-step proving procedure for all control and electrical circuits by imposing low voltage currents and using appropriate indicators to affirm that the circuit is properly identified and connected to the proper device.

b. Calibration of all analysis instruments and control sensors.

c. Performance testing of each individual item of mechanical, electrical, and instrumentation equipment. Performance tests shall be selected to duplicate the operating conditions described in the project manual.

[1]Each of these tests is required even though not specifically noted in detailed specification section.

d. System tests designed to duplicate, as closely as possible, operating conditions described in the project manual.

2. Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.

3. As a condition precedent to receiving progress payments in excess of 75 percent of the contract amount, or in any event, progress payments due to the Contractor eight weeks in advance of the date the Contractor wishes to begin any testing work (whichever occurs earliest in the project schedule), the Contractor shall have submitted all test plans required for the systematic field performance and operational tests for all equipment and systems installed under this contract. The Contractor shall reproduce the plans in sufficient number for the Contractor's purposes and an additional ten copies for delivery to the Engineer. No test work shall begin until the Contractor has delivered the specified number of final test plans to the Engineer.

C. TESTING SCHEDULE:

1. The Contractor shall produce a testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be in bar chart form, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with the Contractor's construction schedule. The schedule shall show the contemplated start date, duration of the test and completion of each test. The test schedule shall be submitted no later than four weeks in advance of the date testing is to begin. The Engineer will not witness any testing work for the purpose of acceptance until the Contractor has submitted a schedule to which the Engineer takes no exception. The test schedule shall be updated weekly, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of this project manual.

a. The cost for the labor to conduct the testing shall be included in the lump sum cost of the project. The cost of test media, chemicals, electric power, and natural gas will be included in the lump sum cost of the project. The cost of test media, chemicals, electric power, and natural gas for any retesting will be accomplished at no additional cost to the Owner.

b. The tests shall be conducted in accordance with applicable industry standard techniques.

1. Local and remote on-site instrumentation equipment may be used to record test data where it is determined to be sufficiently accurate to obtain the necessary data for the performance evaluation.

2. Where special analysis and emissions testing are required, or other resources are needed for testing, the Contractor shall be responsible for providing them.

3. Where local instrumentation is available, manual logging of the data shall be done in conjunction with the instrumentation readings to verify remote instrumentation readings.

4. Any necessary adjustment to test results shall be made by use of standard formulas and relationships.

2. All data values shall be reported both as "measured" and corrected as required by the performance or regulations. Data values shall be stated in the engineering units noted for guaranteed performance or regulatory compliance.

3. Performance Testing shall be witnessed by the Engineer and Owner.

PART 3 – EXECUTION

3.01 GENERAL

A. The Contractor's quality control manager shall organize teams made up of qualified representatives of equipment suppliers, subcontractors, the Contractor's independent testing laboratory, and others, as appropriate, to efficiently and expeditiously calibrate and test the equipment and systems installed and constructed under this contract. The objective of the testing program shall be to demonstrate, to the Engineer's complete satisfaction, that the structures, systems, and equipment constructed and installed under this contract meet all performance requirements and the facility is ready for the commissioning process to commence. In addition, the testing program shall produce baseline operating conditions for the Owner to use in a preventive maintenance program.

3.02 CALIBRATION OF FIXED INSTRUMENTS

A. Calibration of analysis instruments, sensors, gages, and meters installed under this contract shall proceed on a system-by-system basis. No equipment or system performance acceptance tests shall be performed until instruments, gages, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the Engineer.

B. All analysis instruments, sensors, gages, and meters used for performance testing shall be subject to recalibration to confirm accuracy after completion, but prior to acceptance of each performance test. All

analysis instruments, sensors, gages, and meters installed under this contract shall be subject to recalibration as a condition precedent to commissioning.

3.03 START UP TESTS

A. GENERAL:

1. Tests shall consist of the following:

a. Pressure and leakage tests.

b. Electrical testing as specified in the applicable section.

c. Wiring and piping, individual component, loop, loop commissioning, and tuning testing as described in the applicable section.

d. Preoperational checkout for all mechanical and HVAC equipment. Preoperational check-out procedures shall be reviewed and approved by the respective equipment manufacturers.

e. Initial operation tests of all mechanical, electrical, HVAC, and instrumentation equipment and systems to demonstrate compliance with the performance requirements of this project manual.

2. In general, tests for any individual system shall be performed in the order listed above. The order may be altered only on the specific written authorization of the Engineer after receipt of a written request, complete with justification of the need for the change in sequence.

B. PRESSURE AND LEAKAGE TESTS:

1. Pressure and leakage tests (including air tests for gravity lines) shall be conducted in accordance with applicable portions of these. All acceptance tests shall be witnessed by the Engineer. Evidence of successful completion of the pressure and leakage tests shall be the Engineer's signature on the test forms prepared by the Contractor.

C. FUNCTIONAL CHECKOUT:

1. Prior to energization (in the case of electrical systems and equipment), all circuits shall be rung out and tested for continuity and shielding in accordance with the procedures required in elsewhere.

D. COMPONENT CALIBRATION AND LOOP TESTING:

1. Prior to energization (in the case of instrumentation system and equipment), all loops and associated instruments shall be calibrated and tested in accordance with the procedures required in elsewhere.

E. ELECTRICAL RESISTANCE:

1. Electrical resistance testing.

F. PREOPERATIONAL TESTS:

1. Preoperational tests shall include the following:

a. Alignment of equipment using reverse dial indicator method.

b. Preoperation lubrication.

c. Tests per the manufacturers' recommendations for prestart preparation and preoperational check-out procedures.

G. FUNCTIONAL TESTS:

1. GENERAL: Once all affected equipment has been subjected to the required preoperational check-out procedures and the Engineer has witnessed and has not found deficiencies in that portion of the work, individual items of equipment and systems may be started and operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the requirements of these specifications. If available, plant effluent may be employed for the testing of all liquid systems except gaseous, oil, or chemical systems. If not available, potable water shall be employed as the test medium. Test media for these systems shall either be the intended fluid or a compatible substitute. The equipment shall be operated a sufficient period of time to determine machine operating characteristics, including noise, temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, the Contractor shall provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system at no additional cost to the Owner. Disposal methods for test media shall be subject to review by the Engineer. During the functional test period, the Contractor shall obtain baseline operating data on all equipment with motors greater than 1 horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for the Owner to enter in a preventive maintenance system.

Test results shall be within the tolerances set forth in the detailed specification sections of this project manual. If no tolerances have been specified, test results shall conform to tolerances established by recognized industry practice. Where, in the case of an otherwise satisfactory functional test, any doubt, dispute, or difference should arise between the Engineer and the Contractor regarding the test results or the methods or equipment used in the performance of such test, then the Engineer may order the test to be repeated. If the repeat test, using such modified methods or equipment as the Engineer may require, confirms the previous test, then all costs in connection with the repeat test will be paid by the Owner. Otherwise, the costs shall be borne by the Contractor. Where the results of any functional test fail to comply with the contract requirements for such test, then such repeat tests as may be necessary to achieve the contract requirements shall be made by the Contractor at his expense.

The Contractor shall provide, at no expense to the Owner, all power, fuel, compressed air supplies, water, and chemicals, all labor, temporary piping, heating, ventilating, and air conditioning for any areas where permanent facilities are not complete and operable at the time of functional tests, and all other items and work required to complete the functional tests. Temporary facilities shall be maintained until permanent systems are in service.

2. RETESTING: If under test, any portion of the work should fail to fulfill the contract requirements and is adjusted, altered, renewed, or replaced, tests on that portion when so adjusted, altered, removed, or replaced, together with all other portions of the work as are affected thereby, shall, unless otherwise directed by the Engineer, be repeated within reasonable time and in accordance with the specified conditions. The Contractor shall pay to the Owner all reasonable expenses incurred by the Owner, including the costs of the Engineer, as a result of repeating such tests.

3. POSTTEST INSPECTION: Once functional testing has been completed, all machines shall be rechecked for proper alignment and realigned, as required. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the Engineer. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled and inspected. Any defects found during the course of the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the Engineer at no cost to the Owner.

3.04 COMMISSIONING

A. The Contractor shall provide system operation testing. After completion of all start up testing, the Contractor shall fill all process units and process systems, except those employing domestic water, oil, air, or chemicals,

with plant effluent water. All domestic water, oil, air, and chemical systems shall be filled with the specified fluid.

B. Upon completion of the filling operations, the Contractor shall circulate water through the completed facility for a period of not less than 48 hours, during which all parts of the system shall be operated as a complete facility at various loading conditions, as directed by the Engineer. The testing period shall commence after this initial period of variable operation. This testing period shall be 14 days. Should the testing period be halted for any reason related to the facilities constructed or the equipment furnished under this contract, or the Contractor's temporary testing systems, the testing program shall be repeated until the specified continuous period has been accomplished without interruption. All process units shall be brought to full operating conditions, including temperature, pressure, and flow.

C. As-built documents of facilities involved shall be accepted and ready for turnover to the Owner at the time of the testing.

3.05 PERFORANCE TESTING

Performance Testing is defined as a test to demonstrate the specified throughout of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum compliance with the equipment or unit process systems performance requirements and guarantees. (7 days).

3.06 INDEPENDENT TESTING ORGANIZATION

A. The Contractor shall be responsible for the contracting of an Independent Testing Organization and shall be responsible for payment of their services.

B. The testing organization will be under the direct supervision of the Contractor, with input from the equipment and unit process systems suppliers, and the Engineer.

1. All instructions, and any other type contact or correspondence shall be through the Contractor.

2. The Contractor shall submit qualifications for the Independent Testing Organization to the Engineer for review.

3.07 TEST COORDINATION

A. Where required, the Contractor shall furnish an authorized competent representative of the equipment or unit process systems suppliers to attend and coordinate the test program.

1. Test coordinator scope of services shall include preliminary instructions and orientation of Contactor's personnel prior to the actual test, instructions throughout the test period, recommended variations, if required, to assure validity of the test, and posttest instructions for system shutdown or continued operation as required by the Engineer.

2. Instrument readings and other test data shall be tabulated by the Contractor.

3. Data sheet copies shall be submitted to the Engineer for review and analysis at the end of each testing day.

B. The Contractor will work closely with the equipment or unit process systems supplier to aid in coordination of required plant functions involving systems not furnished by the suppliers of the equipment or unit process systems being tested. This shall include but is not limited to support equipment, utilities, and support processes.

3.08 TEST METHODS

A. Methods of data collections and analysis used for Performance Testing to show compliance shall be as required by regulatory agencies, industry standards and as specified with the equipment or unit process systems.

3.09 RESPONSIBILITIES

A. Responsibility for performance testing shall be with the Contractor. These assignments shall be detailed and assigned as part of the detailed test plan.

B. Manual logging of operations parameters shall be the responsibility of the Contractor, equipment, or unit process systems supplier.

C. Collections of samples shall be the responsibility of the Independent Testing Organization and may be performed by the Independent Testing Organization.

D. The Independent Testing Organization shall be responsible for tagging all samples, and for the orderly transfer to the Independent Testing Organization.

1. Both the Contractor and the testing organization shall be responsible for completing a Chain-of-Custody log of all samples.

E. All laboratory testing of samples shall be the responsibility of the Independent Testing Organization and shall be performed at the testing organization's laboratory. The Contractor shall be responsible for operating the equipment or unit process systems.

3.10 REPORTS

A. Reports are required for all tests specified in the individual specifications for equipment and unit process. Four copies of preliminary test reports shall be supplied to the Engineer for review and returned with any applicable notes.

B. Tests reports shall be submitted no later than ten calendar days after testing ends. The Contractor shall assist and furnish required information in a timely manner including operating data sheets.

C. The reports shall include, but not be limited to, the following:

1. Cover. Including name and location of the plant, the equipment or unit process systems tested, name and address of the testing organization, and dates of the test.

2. Certification. A page including a certification by the report preparer that he or she is the person responsible for the test data, and one by the Contractor or equipment or unit process systems certifying authenticity and accuracy of the report.

3. Table of Contents.

4. Introduction. Pertinent background information shall be presented in this Section. The information shall include, but not be limited to, the following:

   a. Equipment or unit process systems tested.
   b. Test purpose.
   c. Name and address of suppliers, and testing organization.
   d. Test dates.
   e. Items of performance criteria tested.
   f. Names of persons present for test.
   g. Any other important background information.

5. Summary. A comprehensive summary of the test results with sufficient information and data necessary to evaluate the process with respect to the applicable performance specifications. This information shall include, but not be limited to, the following:

   a. A summary of the test results.

   b. Comparison of test results with required performance criteria.

   c. Process and operation data or parameters that can be used to verify operation at performance criteria.

   d. A description and results of any analyses of samples collected during the test that supports the test results.

e. Discussion of errors, both real and apparent, in the test.

6. Methods. A description of the sampling and analytical methods used.

7. Operation. Facility Operation during Testing shall contain:

   a. Presentation of the process data for the test, with calculations where necessary to show the solids throughput or production to demonstrate that the operating conditions are sufficiently representative of those required for testing. Calculations may be included in the Appendix.

   b. Process and control equipment flow diagram.

8. Appendix.

   a. A summary of all data used in the calculations, including source, formulas with all terms defined.

   b. Calculations for all data submitted, fully defined.

   c. Copies of all raw field data sheets, including those indicating sampling point locations, and notes.

   d. Laboratory report, complete with analytical data sheets and chain of custody list.

   e. Production and/or operational data.

   f. Calibration procedures and work sheets for sampling equipment.

   g. Copies of calibration records for instrumentation.

   h. Pertinent correspondence concerning test.

   i. Any other information necessary to assist the Owner in making a determination of compliance with the contract documents or to assist the Agency in making a determination of compliance with Federal, State, and Local regulations.

END OF SECTION

INDEX TO

SECTION 02 30 00

SUBSURFACE INVESTIGATION

SECTION 02 30 00

SUBSURFACE INVESTIGATION

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section includes subsurface data logs for information only.

1.02 SOIL INVESTIGATION DATA

A. Subsurface data logs and geotechnical report are available for information only. Actual conditions may vary. If bidders are not satisfied with accuracy and completeness of all available data, they are at liberty to make borings or perform soil investigation work for their own use at its expense. If Contractor chooses to perform his own investigation, work shall be coordinated with the Owner and paid for by the Contractor. Any results from Contractor's investigation shall be shared promptly with the Owner and Engineer. Owner reserves the right to share Contractor's investigation data with other potential bidders if information could affect bidding process.

B. The boring logs and test results are for information of the Contractor. Owner and Engineer assume no responsibility for the information.

PART 2 – PRODUCTS

2.01 GEOTECHNICAL REPORT

A. See attached portions of geotechnical report, completed by Terracon, and dated February 6, 2015, project number EN145129.

PART 3 – EXECUTION

None this Section.

END OF SECTION

INDEX TO

SECTION 02 41 13

SELECTIVE SITE DEMOLITION

SECTION 02 41 13

SELECTIVE SITE DEMOLITION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Extent of selective demolition work is indicated on drawings.

B. Adhere to all SCDHEC (South Carolina Department of Health and Environmental Control) standards and requirements.

1.03 SUBMITTALS

A. Schedule: Submit schedule indicating proposed methods and sequence of operations for selective demolition work to Owner's representative for review prior to commencement of work. Include coordination for shut–off, capping, and continuation of utility services as required, together with details for dust and noise control protection. Include schedule and location for return of any items identified on plans that are to be delivered to Owner.

1.04 JOB CONDITIONS

A. Condition of Structures: Owner assumes no responsibility for actual condition of items to be demolished.

B. Partial Demolition and Removal: Items designated for removal shall be removed as work progresses. Transport salvaged items from site as they are removed. Storage or sale of removed items on site shall not be permitted.

C. Protections: Provide temporary barricades and other forms of protection as required to protect Owner's personnel and general public from injury due to selective demolition work.

D. Protect all existing structures that are designated to remain throughout demolition operations. Remove protections at completion of work.

1.05 DAMAGES

A. Promptly repair damages caused to adjacent facilities by demolition work at no cost to Owner.

1.06 TRAFFIC

A. Conduct selective demolition operations and debris removal in a manner to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

B. Do not close, block or otherwise obstruct streets, walks, or other occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways.

1.07 EXPLOSIVES

A. Use of explosives will not be permitted.

1.08 UTILITY SERVICES

A. Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.

B. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.

1.09 ENVIRONMENTAL CONTROLS

A. Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing regulations pertaining to environmental protection.

B. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

1.10 MEASUREMENT AND PAYMENT

A. There will be no measurement for selective demolition. Payment will be made at the contract lump sum price. Payment will include equipment, labor, materials, protection, clean–up, disposal, and all work necessary to complete the selective demolition shown on the construction drawings.

PART 2 – PRODUCTS

None in this section

PART 3 – EXECUTION

3.01 PREPARATION

A. Prior to commencement of selective demolition work, check areas in which work will be performed. Photograph or video existing conditions of surfaces, equipment, or surrounding properties that could be misconstrued as damage resulting from

selective demolition work. Review items of concern onsite with Owner. File with Owner or Owner's Representative prior to starting work.

B. Cover and protect equipment and fixtures to remain from soiling or damage when demolition work is performed in areas from which such items have not been removed.

3.02 DEMOLITION

A. Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on drawings in accordance with demolition schedule and governing regulations.

B. Demolish concrete in small sections. Cut concrete at junctures with construction to remain using power–driven masonry saw or hand tools. Do not use power–driven impact tools.

C. Completely fill below–grade areas and voids resulting from demolition work. Provide fill consisting of approved earth, gravel and sand, free of trash and debris, stones over two-inch diameter, roots, or other organic matter.

D. If unanticipated mechanical, electrical, or structural elements, which conflict with intended function or design, are encountered, investigate and measure both nature and extent of the conflict. Submit report to Owner in written, accurate detail. Pending receipt of directive from Owner, rearrange selective demolition schedule as necessary to continue overall job progress without delay.

3.03 SALVAGE MATERIALS

A. All equipment and materials desired by Owner shall be delivered to a designated location, not further than two miles from the job site. Desired equipment may include, but not be limited to, generator, transfer switch, pumps, motors, controls, valves, electrical panels, and other items.

B. Any articles of historic significance will remain the property of the Owner. Notify Owner immediately if such items are encountered. Stop demolition orexcavation work and obtain acceptance regarding further historical investigation, method of removal or salvage for Owner.

3.04 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove debris, rubbish and other materials resulting from demolition operations from site. Transport and legally dispose of materials off site.

B. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.

C. Burning of removed materials is not permitted on project site.

3.05 CLEAN–UP AND REPAIR

A. Upon completion of demolition work, remove tools, equipment and demolished materials from site. Remove protections and leave site clean.

B. Repair demolition performed in excess of required work. Return structures and surfaces to remain to the condition existing prior to commencement of selective demolition work. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.

C. Fill in all voids created by selective demolition and grade site to drain. Grass all disturbed areas for erosion control.

END OF SECTION

SECTION 09 90 00

PAINTING AND PROTECTIVE COATINGS

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. C203, Coal–Tar Protective Coatings and Linings for Steel Water Pipelines–Enamel and Tape–Hot–Applied.
   b. C209, Cold–Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   c. C213, Fusion–Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF): 61, Drinking Water System Components Health Effects.
5. Occupational Safety and Health Act (OSHA).
6. The Society for Protective Coatings (SSPC):
   a. P A 2, Measurement of Dry Coating Thickness with Magnetic Gages.
   b. P A 3, Guide to Safety in Paint Applications.
   c. SP 1, Solvent Cleaning.
   d. SP 2, Hand Tool Cleaning.
   e. SP 3, Power Tool Cleaning.
   f. SP 5, White Metal Blast Cleaning.
   g. SP 6, Commercial Blast Cleaning.
   h. SP 7, Joint Surface Preparation Standard Brush–Off Blast Cleaning.
   i. SP 10, Near–White Blast Cleaning.
   j. SP 11, Power Tool Cleaning to Bare Metal.

k. SP 12, Surface Preparation and Cleaning of Metals Water jetting Prior to Recoating.

l. SP 13, Surface Preparation of Concrete.

m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

7. Master Painters Institute (MPI)

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCI: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. Mil: Thousandth of an inch.
6. PDS: Product Data Sheet.
7. PSDS: Paint System Data Sheet.
8. PVC: Polyvinyl Chloride.
9. SFPG: Square Feet per Gallon.
10. SFPGPC: Square Feet per Gallon per Coat.
11. SP: Surface Preparation.

1.03 SUBMITTALS

A. Action Submittals:

1. Data Sheets:

a. For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS form is appended to the end of this section.

b. For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.

c. Technical and performance information that demonstrates compliance with Specification.

d. Furnish copies of paint system submittals to the coating applicator.

e. Indiscriminate submittal of only manufacturer's literature is not acceptable.

f. Provide a cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.

g. Printout of current "MPI Approved Products List" with the proposed product highlighted for those products specified in paragraph "Architectural Paint Systems and Application Schedule" herein.

2. Detailed chemical and gradation analysis for each proposed abrasive material.

3. Paint Color Schedule: List of paint colors selected (manufacturer, name and number) and corresponding locations of application.

4. Samples:

a. Reference Panel:

1) Paint & Coatings:

(a) Unless otherwise specified, before painting work is started, prepare samples as required in "Mockup" herein.

(b) Furnish additional samples as required until colors, finishes, and textures are approved.

(c) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:

1. Applicator's Qualification: List of references substantiating experience.

2. Coating manufacturer's Certificate of Compliance, in accordance with Section 01 00 01, General Requirements.

3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.

4. Manufacturer's written verification that submitted material is suitable for the intended use and is compatible with any other products applied to the same surface.

5. Manufacturer's written instructions and special details for applying each type of paint and coating.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds (VOC).

2. Perform surface preparation and painting in accordance with recommendations of the following:

a. Paint manufacturer's instructions.

b. SSPC P A 3, Guide to Safety in Paint Applications.

c. Federal, state, and local agencies having jurisdiction.

C. MPI Standards for Architectural Paint Systems:

1. Products listed in paragraph "Architectural Paint Systems and Application Schedule" shall comply with MPI Standards indicated and listed in current "MPI approved Products List".

2. Preparation and workmanship of products listed in paragraph "Architectural Paint Systems and Application Schedule" shall comply with requirements in "MPI Architectural Painting Specification Manual".

D. Mockup:

1. Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

2. Unless noted otherwise, prepare minimum 8–inch by 10–inch sample with type of paint and/or coating and application specified on similar substrate to which paint and/or coating is to be applied.

a. Wall Surfaces: Provide samples on at least 100 sq. ft. of wall surface.

b. Doors: Provide full size samples for interior and exterior doors.

3. If preliminary color selections are not approved, additional benchmark samples of additional colors selected by Architect shall be provided by the Contractor at no added cost to Owner.

4. Final approval of color selections will be based on benchmark samples which shall serve as the quality standard for final finishes.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

a. Product name or title of material.
b. Product description (generic classification or binder type).
c. Manufacturer's stock number and date of manufacture.
d. Contents by volume, for pigment and vehicle constituents.
e. Thinning instructions.
f. Application instructions.
g. Color name and number.

B. Shipping:

1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.
3. Contractor shall repair damages that have occurred during transit, to the satisfaction of the Owner, or shall supply a replacement.

C. Storage:

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being top coated, or less time if recommended by coating manufacturer.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

B. Minimum of 5 years' verifiable experience in manufacture of specified product.

C. Each of the following manufacturers is capable of supplying most of the paint products specified in paragraph "Architectural Paint Systems and Application Schedule" herein:

1. Sherwin Williams.
2. Tnemec.
3. PPG Architectural Finishes.
4. Benjamin Moore & Co.
5. Rose Talbert Paints

D. Acceptable manufacturers of other paints and/or coatings are as specified in Section 3.

2.02 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

A. General:

1. Manufacturer's highest quality products suitable for intended service.

2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.

3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	Definition
Acrylic Latex	Single–component, finish as required.
Acrylic Latex (Flat)	Flat latex
Acrylic Sealer	Clear acrylic
Alkyd (Semigloss)	Semigloss alkyd
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil.
Alkyd Wood Primer	Flat alkyd
Bituminous Paint	Single–component, coal–tar pitch based.
Block Filler	Primer–sealer designed for rough masonry surfaces, 100% acrylic emulsion.
Coal–Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service.
DTM Acrylic Primer	Surface tolerant, direct–to–metal water borne acrylic primer.
DTM Acrylic Finish	Surface tolerant, direct–to–metal water borne acrylic finish coat.
Elastomeric Polyurethane	100% solids, plural component, spray applied, high build, elastomeric polyurethane coating, suitable for the intended service.
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required.
Epoxy Nonskid (Aggregated)	Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged

Product	Definition
	separately
Epoxy Primer–Ferrous Metal	Anticorrosive, converted epoxy primer containing rust–inhibitive pigments.
Epoxy Primer–Other	Epoxy primer, high–build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated.
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service.
Fusion Bonded, TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster–Carr Supply Corporation., Elmhurst, IL; RL 736 manufactured by Amrep, Inc., Marietta, GA.
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat.
High Solids Polyurethane	Two–component, low VOC, aliphatic, acrylic polyurethane resin coating having a minimum of 65% volume solids; high gloss or semi gloss finish
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for top coating.
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats.
NSF Epoxy	Polyamidoamine epoxy, approved for potable water contact and conforming to NSF 61
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Polyurethane Enamel	Two–component, aliphatic or acrylic based polyurethane; high gloss finish
Rust–Inhibitive Primer	Single–package steel primers with anticorrosive pigment loading
Sanding Sealer	Co–polymer oil, clear, dull luster.
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based.
Stain, Concrete	Acrylic, water repellant, penetrating stain.

Product	Definition
Stain, Wood	Satin luster, linseed oil, solid or transparent as required.
Varnish	Non–pigmented vehicle based on a variety of resins (alkyd, phenolic, urethane) in gloss, semigloss, or flat finishes, as required.
Water Base Epoxy	Two–component, polyamide epoxy emulsion, finish as required.

2.04 MIXING

A. Multiple–Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple–component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.05 SHOP FINISHES

A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.

B. Surface Preparation: Provide Contractor minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

C. Shop Coating Requirements:

1. When required by equipment Specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie–coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie–coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

2.06 ARCHITECTURAL PRODUCTS

The following is to be applied to all paint systems except where specifically noted otherwise herein and on the Drawings.

A. Exterior Metal Primer: Primer, Epoxy, Anti-Corrosive, for Metal: MPI #101

B. Exterior Wood Primer: Primer, Alkyd for Exterior Wood: MPI #5.

C. Exterior Water-Based Paint: Light Industrial Coating, Exterior, Water Based, Gloss (Gloss Level 6): MPI #164.

D. Exterior Latex Paint: Exterior Latex (Semigloss) MPI #11 (Gloss Level 5).

E. Interior Primers / Sealers: Interior Latex Primer/Sealer MPI #50.

F. Interior Metal Primers:

   a. Quick-Drying Alkyd Metal Primer MPI #76.

   b. Waterborne Galvanized-Metal Primer: MPI #134.

G. Interior Latex Paints:

   a. Interior Latex (Eggshell) MPI #52 (Gloss Level 3).

   b. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).

H. Epoxy Coatings: Epoxy-Modified Latex, Interior, Gloss (Gloss Level 6) MPI #115.

PART 3 – EXECUTION

3.01 GENERAL

A. Provide Contractor minimum 7 days' advance notice to start of field surface preparation work and coating application work.

B. Perform the Work only in presence of Contractor, unless Engineer grants prior approval to perform the Work in Contractor's absence.

C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Contractor.

3.02 EXAMINATION

A. Factory Finished Items:

1. Schedule inspection with Contractor before repairing damaged factory-finished items delivered to Site.

2. Repair abraded or otherwise damaged areas on factory–finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.

B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

C. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent
2. Masonry: 12 percent
3. Wood: 15 percent
4. Gypsum Board: 12 percent

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry. Commencement of coating application constitutes Contractor's acceptance of substrates and conditions.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated in paragraph "Architectural Paint Systems and Application Schedule".

B. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:

a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.

b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.

c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power–assisted hand tools.

d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.

e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations

caused by stains of rust, stains of mill scale, or stains of previously applied coatings.

f. SP 7, Brush–Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.

g. SP 10, Near–White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.

h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power–assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.

i. SP 12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating: Surface preparation using high–pressure and ultrahigh–pressure water jetting to achieve specified surface cleanliness condition. Surface cleanliness conditions are defined in SSPC SP 12 and are designated WJ–I through WJ–4 for visual surface preparation definitions and SC–I through SC–3 for nonvisual surface preparation definitions.

2. The words "solvent cleaning," "hand tool cleaning," "wire brushing," and "blast cleaning," or similar words of equal intent in these Specifications or in paint manufacturer's specification refer to the applicable SSPC Specification.

3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu–blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.

4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.

5. Hand tool clean areas that cannot be cleaned by power tool cleaning.

6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.

7. Welds and Adjacent Areas:

a. Prepare such that there is:

1) No undercutting or reverse ridges on weld bead.

2) No weld spatter on or adjacent to weld or any area to be painted.

3) No sharp peaks or ridges along weld bead.

b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

8. Preblast Cleaning Requirements:

a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.

b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.

c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.

9. Blast Cleaning Requirements:

a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.

b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.

c. Use only dry blast cleaning methods.

d. Do not reuse abrasive, except for designed recyclable systems.

e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.

10. Post–Blast Cleaning and Other Cleaning Requirements:

a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.

b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

C. Galvanized Metal Surface Preparation:

1. Prepare in accordance with ASTM D 6386 and recommended procedures from the American Galvanizers Association (AGA).

2. Notify galvanizer that steel will be painted.

3. Newly Galvanized Metal (48 hours or less since galvanizing):

   a. Grinding: removed excess zinc, remove dross particles, bumps, runs and drips by hand grinder. If process removes too much zinc, surface must be repaired in accordance with ASTM A780.
   b. Ensure surface is free of oil, grease, dirt and other organic materials. If it is not, see Partially Weathered for cleaning procedure.
   c. Rinse thoroughly and dry.
   d. Profile by sweep blasting at a maximum pressure of 40 psi, wash primer or acrylic pre-treatment. Take care not to damage the galvanized coating.

4. Partially Weathered Metal (2 days – 12 months from galvanizing):

   a. Grinding as previously defined for Newly Galvanized Metal.
   b. Clean surface of organic compounds and wet storage stain using alkaline solution or solvent cleaning.
   c. Rinse thoroughly and dry.
   d. Profile as previously defined for Newly Galvanized Metal.

5. The pressure of cleaning or rinsing performed must not exceed 1450 psi.

6. Apply paint or coating within 12 hours of drying.

D. Nonferrous Metal Alloy Surface Preparation:

1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.

2. Remove oil and grease by wiping or scrubbing surface with suitable solvent, rag, and brush. Use clean solvent and clean rag for final wiping to avoid contaminating surface.

3. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

E. Concrete Surface Preparation:

1. Do not begin until a minimum of 30 days after concrete has been placed, and longer if directed by product manufacturer.

2. Meet requirements of SSPC SP 13.

3. Adhere to manufacturer's recommendations for preparation of the concrete surface. Ensure surface is free from grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter.

4. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after preparation.

5. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

F. Plastic Surface Preparation:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.

2. Large areas may be power sanded or brush–off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

G. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.

2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.

3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:

a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.

b. Brush–off blasting.

c. Water blasting.

4. Do not damage masonry mortar joints or adjacent surfaces.

5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.

6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.

7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

H. Wood Surface Preparation:

1. Replace damaged wood surfaces or repair in a manner acceptable to Contractor prior to start of surface preparation.

2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer, prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.

3. Round sharp edges by light sanding prior to priming.

4. Filler:

   a. Synthetic–based wood putty approved by paint manufacturer for paint system.

   b. For natural finishes, color of wood putty shall match color of finished wood.

   c. Fill holes, cracks, and other surface irregularities flush with surrounding surface and sand smooth.

   d. Apply putty before or after prime coat, depending on compatibility and putty manufacturer's recommendations.

   e. Use cellulose type putty for stained wood surfaces.

   f. Ensure surfaces are clean and dry prior to painting.

I. Gypsum Board Surface Preparation: Typically, new gypsum board surfaces need no special preparation before painting.

1. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.

3.05 SURFACE CLEANING

A. Brush–off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.

2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.

3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.

4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.

5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.

6. Repair or replace surface damaged by blast cleaning.

B. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.

2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for new, interior and exterior masonry, concrete, and metal, surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.

2. Apply coatings and paint in accordance with these Specifications and manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.

3. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.

4. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.

5. Water–Resistant Gypsum Board: Use only solvent type paints and coatings.

6. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.

7. Keep paint materials sealed when not in use.

8. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.

2. Prepare surface and apply primer in accordance with System No. 10 specification.

3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

C. Porous Surfaces, Such As Concrete and Masonry:

1. Repairs shall be completed using products specified in Section 03 30 00 Cast-In-Place Concrete.
2. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects that may inhibit or prevent adequate application of coating.
3. Prime Coat: If it acceptable to the manufacturer, prime coat may be thinned to provide maximum penetration and adhesion. The reduction volume shall be determined by the manufacturer specific to the density and type of coating being applied. Reduction shall not be implemented if it voids the warranty of any product.
4. Surface Specified to Receive Water Base Coating: For most applications, surface shall be damp just prior to application of coating, but free of running water. Verify this requirement with manufacturer for specified product.

D. Film Thickness and Coverage:

1. Number of Coats:
   a. Minimum required without regard to coating thickness.
   b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
   a. Do not exceed coating manufacturer's recommendations.
   b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
   a. Perform with properly calibrated instruments.
   b. Recoat and repair as necessary for compliance with Specification.
   c. Coats are subject to inspection by Contractor and coating manufacturer's representative.
4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 FIRE RATED ASSEMBLIES

A. Permanently identify corridor partitions, smoke stop partitions, horizontal exit partitions, exit enclosures and fire walls. Above decorative ceiling line and in concealed spaces, apply a minimum one-inch wide red line interrupted at maximum 15-ft spacing with the wording "XX HOUR FIRE AND SMOKE BARRIER -

PROTECT ALL OPENINGS" in 4-inch high letters with "XX" designating the appropriate hourly rating.

3.08 FIELD QUALITY CONTROL

A. Owner reserves the right to invoke test procedure at any time and as often as Owner deems necessary during the period when paint is being applied.

1. Owner may direct Contractor to stop painting if test results show material being used does not comply with specified requirements. Contractor shall remove noncomplying paint from Project site, pay for testing, and repaint surfaces previously coated with the noncomplying paint.

B. Testing:

Testing is to be performed on the waterproof and anti-corrosion coatings applied to the interior surfaces of the Basins.

1. Thickness and Continuity Testing:

a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC P A 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.

b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE RP0188.

c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE RP0188.

d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

2. Testing Equipment:

a. Provide magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.

b. Provide low–voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high–build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M–I.

c. Provide high–voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

D. Unsatisfactory Application:

1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
3. Repair defects in accordance with written recommendations of coating manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with recommendations of paint manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
3. Apply finish coats, including touchup and damage–repair coats in a manner that will present a uniform texture and color–matched appearance.

3.08 MANUFACTURER'S SERVICES

A. Coating manufacturer's representative shall be present at Site for the application of the waterproof and anti-corrosion coatings for the Basins as follows:

1. On first day of application of any coating system.
2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
3. During thickness and continuity testing to verify conformance with project and manufacturer requirements.
4. As required to resolve field problems attributable to or associated with manufacturer's product.
5. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.09 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.

C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.10 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces–in accordance with the following application schedule and the environmental types defined in Section 01 00 01, General Requirements. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. System No. 2 Submerged Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	Prime in accordance with manufacturer's recommendations	
	Coal–Tar Epoxy –OR– High Build Epoxy	2 coats, 16 MDFT 2 coats, 16 MDFT

1. Use on the following items or areas:

   a. New metal surfaces located in submerged environment type.
   b. New metal surfaces above maximum liquid surface that are a part of submerged equipment.
   c. Submerged surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gates, gate guides, thimbles, and structural steel that are embedded in concrete.
   d. Interior surfaces of steel piping noted in the Piping Schedule.

C. System No. 4 Galvanized Metal, Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
See Preparation section of this specification	Zinc-Rich Primer	1 coat, per mfr
	Top Coat – Acrylic Latex	1 coat, per mfr

1. Use on the following items or areas:

   a. Exposed new galvanized metal surfaces located in interior equipment/blower room
   b. Exposed galvanized metal deck: exterior and interior.
   c. Exposed galvanized structural steel, including beams and columns of monorail and porch framing.
   d. Exposed galvanized steel stair and platform framing (exterior).
   e. Galvanized steel lintels.
   f. Galvanized exterior doors and frames.

D. System No. 5 Exposed Metal, Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near–White Blast Cleaning	Epoxy Primer – Ferrous Metal	1 coat, 2.5 MDFT
	Polyethylene Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:

   a. Miscellaneous exposed new metal surfaces inside the 2nd level of the building.

   b. Interior doors and frames.

E. System No. 6 Exposed Metal Atmospheric:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Rust Inhibitive Primer	1 coat, 2 MDFT
	Alkalyd Enamel	2 coats, 4 MDFT

1. Use on the following items or areas:

   a. Exposed new metal surfaces including vents, exterior metal ductwork, flashing, sheet metalwork and miscellaneous architectural metal trim.

   b. Apply surface preparation and primer to surfaces prior to installation. Finish coats need only be applied to surfaces exposed after completion of construction.

F. System No. 8 Buried Metal General:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near White Blast Cleaning	Coal–Tar Epoxy	2 coats, 125 microns each
	Coal-Tar Primer, Coal-Tar Enamel	1 coat, per mfr 2 coats, hot applied per mfr

1. Use on the following items or areas:

   a. Buried, below grade portions of steel items, except buried stainless steel or ductile iron and the following specific surfaces:

      1) Fasteners and accessories of buried piping related items.

G. System No. 10 Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Nonferrous Metal Alloy Surface Preparation	Epoxy Primer–Other	As recommended by coating manufacturer Remaining coats as required for exposure

1. Use on the following items or areas:
   a. Aluminum handrail, grating, panels, and miscellaneous components both interior and exterior.
   b. After application of System No. 10, apply finish coats as required for exposure. For handrail apply per specifications herein. For other items apply per manufacturer recommendations.

H. System No. 11 Galvanized Metal Repair:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SPI) Followed by Hand Tool (SP 2), Power Tool (SP 3) or Brush off Blast (SP 7)	Organic Zinc Rich Primer	1 coat, 3 MDFT

1. Use on the following items or areas:
   a. Galvanized surfaces that are abraded, chipped or otherwise damaged.

I. System No. 19 Concrete Tank Waterproof Coating:

Surface Prep.	Paint Material	Min. Coats, Wet Thickness
As specified by the manufacturer	CIM 61TN Epoxy Primer	2 coat, 5 mil (wet) – recoat w/in 48 hrs
	CIM 1000	2 coats, 60* mil (dry)

*Apply extra thickness at corners, intersections, angles and over joints.

1. Use on the following items or areas:
   a. Walls and base slab of Chlorine Contact Basin.

J. System No. 20 Concrete Tank Anti-Corrosion Coating:

Surface Prep.	Paint Material	Min. Coats, Dry Thickness
As specified by the Manufacturer	Raven 404 System	3 coats min, 60 mil

1. Use on the following items or areas:
   a. Walls & base slab of Anoxic Basin, Pre-Aeration Basins, Splitter Box Channel, and Membrane Basins.
   b. Underside of all concrete slabs and walkways over all Basins.
   c. Coating of all exposed piping inside of all basins.

K. System No. 21 Decorative Abrasion Resistant Concrete Finish:

Surface Prep.	Paint Material	Min. Coats, Cover
Shot blast concrete as specified by manufacturer	Stontec UTF, by Stonhard Inc.	As specified by manufacturer

1. Use on the following items or areas:
   a. Interior floors on 2nd floor of the building.

L. System No. 22 Decorative Abrasion Resistant Non-Slip Concrete Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
Shot blast concrete as specified by manufacturer	Stontec UTF with White Texture, by Stonhard Inc.	As specified by manufacturer

2. Use on the following items or areas:
   a. Exterior concrete slab on 2nd level at top of stairs and at covered area between monorail bay and building CMU wall.

M. System No. 23 Chemical–Resistant Non-Slip Floor and Wall Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
Shot blast concrete as specified by manufacturer	Stonchem 830, by Stonhard Inc.	As specified by manufacturer

3. Use on the following items or areas:
   a. Interior slab on grade and equipment slabs of the Equipment Room, Equipment Support Room and Chemical Room.

b. Lower 6 inches of all walls in the Equipment Room, Equipment Support Room and Chemical Room.

N. System No. 25 Exposed PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Semigloss	2 coats, 320 SFPGPC

1. Use on the following items or areas:

   a. All exterior, exposed–to–view PVC and CPVC surfaces.

O. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

1. Use on aluminum surfaces embedded or in contact with concrete.

P. System No. 29 Fusion Bonded Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near–White Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT

1. For steel pipe and fittings, meet all requirements of AWWA C2I3.
2. Use on the following items:

   a. Interior and exterior of valves as specified in Section 40 27 02 Process Valves and Operators.

3.11 ARCHITECTURAL PAINT SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. System No. 102 Wood, Exterior:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Wood Surface Preparation	Alkyd Wood Primer, MPI #5	1 coat
	Latex, exterior, matching topcoat	1 coat
	Latex, exterior gloss (Gloss Level 6), MPI #119	1 coat

1. Use on the following items or areas:
   a. All exterior wood.

C. System No. 1 06 Wood, Interior, Latex System: n/a

D. System No. 109 Masonry, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Masonry Surface Preparation	Block Filler	1 coat, 75 SFPG
	Acrylic Latex (Semigloss)	2 coats, 240 SFPGPC

1. Use on the following items or areas:
   a. Interior CMU walls in Centrifuge Building.

E. System No. 112 Concrete, Flat:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Acrylic Latex (Flat)	2 coats, 240 SFPGPC

1. Use on the following items or areas:

a. Basin exterior walls.

b. Lower wall of building on North side.

F. System No. 114 Gypsum Board, Latex System:

Surface Prep.	Paint Material	Min. Coats
In accordance with Paragraph Gypsum Board Surface preparation	Interior Latex Primer Sealer	1 coat
	Interior latex matching topcoat	1 coat
	Interior latex (eggshell)	1 coat

1. Use Latex System MPI INT 9.2A on the following items or areas:

   a. Interior gypsum board in dry areas.

G. System No. 115 Gypsum Board, Epoxy-Modified Latex System:

Surface Prep.	Paint Material	Min. Coats
In accordance with Paragraph Gypsum Board Surface preparation	Skim coat of joint compound	1 coat
	Primer sealer, latex, interior	1 coat
	Epoxy-modified latex, interior, gloss (Gloss Level 6)	2 coats

1. Use Epoxy-Modified Latex System MPI INT 9.2F on the following items or areas:

   a. Interior gypsum board in wet areas.

3.12 COLORS

A. Provide as designated by the Architect in Finish Schedule.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Equipment Colors:

1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
2. Paint equipment and piping one color as selected.
3. Paint non – submerged portions of equipment the same color as the piping it serves, except as itemized below:
    a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
    b. Fire Protection Equipment and Apparatus: OSHA Red.
    c. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

D. Pipe Identification Painting:

1. Color code non – submerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
2. Pipe Color Coding: In accordance with Piping Schedule and/or selected by the Engineer.
3. Pipe Supports (for metals that are not galvanized steel, aluminum and stainless steel): Painted light gray, as approved by Engineer.
4. PVC and CPVC pipe located inside of buildings and enclosed structures will not require painting except as noted or scheduled.

3.13 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification:

1. Paint System Data Sheet (PSDS).
2. Product Data Sheet (PDS).

END OF SECTION

PAINT PRODUCT DATA SHEET

Complete and attach manufacturer's Technical Data Sheet to this PDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio:_____

Maximum Permissible Thinning: _____

Ambient Temperature Limitations: min.:_____ max: _____

Surface Temperature Limitations: min.:_____ max: _____

Surface Profile Requirements: min.:_____ max: _____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

PAINT SYSTEM DATA SHEET

Complete this PDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PDS.

Paint System Number (from Spec):		
Paint System Title (from Spec):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

SECTION 10 14 00

IDENTIFYING DEVICES

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American National Standards Institute (ANSD:

   a. A13.1, Schemes for the Identification of Piping Systems.
   b. A117.1, Buildings and Facilities–Accessibility and Usability for Physically Handicapped People.
   c. D6.1, Manual on Uniform Traffic Control Devices for Streets and Highways.

2. American Society for Testing and Materials (ASTM): A53, Standard Specification for Pipe, Steel, Black and Hot–Dipped, Zinc–Coated Welded and Seamless.

3. The Chlorine Institute, Inc.: WC–1, Wall Chart: Handling Chlorine Cylinders and Ton Containers.

4. Federal Specifications (FS): L–P–387 A(1), Plastic Sheet, Laminated, Thermosetting (for Designation Plates).

5. International Conference of Building Officials (ICBO): Uniform Fire Code (UFC).

6. National Fire Protection Association (NFPA):

   a. 49, Hazardous Chemicals Data.
   b. 704, Standard System for the Identification of the Fire Hazards of Materials.

7. Occupational Safety and Health Act (OSHA).

1.02 SUBMITTALS

A. Shop Drawings:

1. Drawings showing layouts, actual letter sizes and styles, and project–specific mounting details for every sign type.

2. Manufacturer's literature showing letter sizes and styles, sign materials, and standard mounting details.

B. Samples: One full size for each type of nameplate, sign, and label specified.

C. Quality Control Submittals: Manufacturer's installation instructions.

PART 2 – PRODUCTS

2.01 DOOR NAMEPLATES (TYPE A)

A. Material: Three–ply laminated fiberglass, minimum 1/8–inch thick, with contrasting color core message layer between two clear weather–resistant surface layers.

B. Manufacturers:

1. Brady Signmark
2. Seton Name Plate Corp.
3. Approved Equal

C. Finish: Non –directional matte.

D. Size: See Sign Schedule (attached)

E. Letters:

1. Size: l–inch high unless noted otherwise in schedule.
2. Color: See Sign Schedule (attached).
3. Style: See Sign Schedule (attached).
4. Message Text: See Sign Schedule (attached).

2.02 PICTORIAL SYMBOLS (TYPE G)

A. Material: Three–ply laminated fiberglass, minimum 1/8–inch thick, with contrasting color core message layer between two clear weather–resistant surface layers. Use international handicapped unisex toilet symbol.

B. Manufacturers:

1. Brady Signmark
2. Seton Name Plate Corp.
3. Approved Equal

C. Size: See Sign Schedule (attached).

D. Manufacture: ANSI A1l7.l, Section 4.30.

2.03 METAL SIGNS (TYPE B):

A. Material: Baked enamel finished 20–gauge (minimum) steel or 18–gauge (minimum) aluminum signs.

B. Manufacturers:

1. Seton Name Plate Corp.
2. Nutheme Illustrated Safety Co.
3. Approved Equal

2.04 HAZARDOUS MATERIAL SIGNS (TYPE H):

A. Conform to NFPA 704, 49 and NFPA HAZ–01.

B. Material: Fiberglass 1/8 inch thick or Reflective sheeting applied to 0.040–inch thick aluminum.

C. Background, Letters, and Numbers: Die–cut vinyl with pressure sensitive adhesive.

D. Manufacturers:

1. Brady Signmark.
2. Seton Name Plate Corp.
3. Approved Equal

2.05 CUSTOM SIGN (TYPE Q):

A. Provide a facility plaque made by Impact Signs of LaGrange, IL or approved equal.

B. Size: 16” high x 18” long

C. Material: Cast Bronze

D. Finish: Light Oxidized

E. Background Texture: Stipple, Black

F. Border: Single

G. Attachment: Rosette #4

H. Text: Copperplate, Capital Letters

I. Message: See attached mock-up of plaque

2.06 IDENTIFICATION LABELS

A. PVC Pipe Labels and Flow Direction Arrows:

1. Lettering and Arrows: Black print.

2. Background: OSHA safety yellow.

3. Material: Manufacture from or encase in outdoor grade plastic or vinyl that will resist damage or fading from wash-down, sunlight, mildly corrosive atmosphere, dirt, grease, and abrasion.

4. Label, Lettering Size, and Color: ANSI A13.I.

5. Message: See Piping Schedule.

6. Labels:

   a. Snap–Around Type: Size for finished outside diameter of pipe and insulation.
   b. For 6 Inches and Over Diameter Pipe: May furnish strap–on type fastened without use of tools with plastic or stainless steel straps.
   c. Firmly grip pipe so labels remain fixed in vertical pipe runs.

7. Manufacturers and Products:

   a. T & B/Westline, Rariton, NJ; Model WSS Snap–Around.
   b. Seton Name Plate Corp., New Haven, CT; Setmark Series.

8. Note: All other pipes shall have painted labels; see Section 09 90 00, Painting and Protective Coating.

B. Equipment Labels:

1. Applies to equipment with assigned tag numbers wherever specified on Drawings.

2. Lettering: Black bold face, 3/4–inch minimum high.

3. Background: OSHA safety yellow.

4. Materials: Either of the following:

   a. Aluminum or stainless steel base with a baked–on finish that is suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
   b. Fiberglass with fiberglass–encased lettering.

5. Furnish l–inch margin on each end of label for mounting. On fiberglass labels furnish grommets at each end for mounting.

5. Size:

   a. Two inches minimum and 3 inches maximum high by 14 inches minimum and 18 inches maximum long.
   b. Furnish same size base dimensions for all labels.

7. Message: Equipment names and tag numbers as used in sections where equipment is specified.

8. Manufacturers and Products:

   a. T & B/Westline Co., Rariton, NJ; Type KQ.
   b. Seton Name Plate Corp., New Haven, CT; Style EB.

c. W. H. Brady Co., Milwaukee, WI; Fiber–Shield.

2.04 ANCILLARY MATERIALS

A. Fasteners: Stainless steel screws or bolts of appropriate sizes.

B. Pipe Posts: 2–1/2–inch galvanized steel pipe meeting ASTM A53, Type S, Grade B.

C. Chain: Type 304 stainless steel, No. 16 single jack chain or No.2 double loop coil chain.

PART 3 – EXECUTION

3.01 INSTALLATION –GENERAL

A. In accordance with manufacturer's recommendations.

B. Mount securely, plumb, and level.

3.02 DOOR NAMEPLATES AND PICTORIAL SYMBOLS

A. Attach to doors or walls adjacent to doors with self–sticking permanent removable adhesive. See Door Schedule for locations and messages.

B. Mount with bottom of nameplate at 5 feet 6 inches above floor.

3.03 SIGNS

A. Fasten to walls or posts or hang as scheduled. Anchor in place for easy removal and reinstallation with ordinary hand tools.

B. Information, Exit, and Safety Signs:

1. Install facing traffic. Locate for high visibility with minimum restriction of working area around walkways and equipment.

2. Removable with ordinary hand tools without leaving scars on structure or equipment.

C. Hazardous Material Signs:

1. Install where required by NFPA No. 704 and UFC, Chapter 79.

2. Install at entrances to spaces where hazardous materials are stored, dispensed, used, or handled and on sides of stationary tanks.

3. Specific Materials:

Hazardous Materials					
Mark	**Material**	**Health Hazard (Blue)**	**Flammability Hazard (Red)**	**Instability Hazard (Yellow)**	**Special Hazard (White)**
See Schedule	Emulsion Polymer	1	1	0	
See Schedule	Citric Acid	2	1	0	
See Schedule	Ferric Chloride (35 – 40% solution)	3	0	0	
See Schedule	Sodium Hydroxide (10 – 30% solution)	2	0	0	
See Schedule	Sodium Hypochlorite (12 – 15% solution)	2	0	0	
See Schedule	No 2 Diesel Fuel	0	2	0	
See Schedule	Potable Water	0	0	0	4
See Schedule	Non Potable Water (effluent)	7	0	0	0

3.04 IDENTIFICATION LABELS

A. PVC Pipe Labels and Flow Indication Arrows:

1. Locate at all connections to equipment, valves, or branching fittings at wall boundaries.

2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.

3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.

4. Supplementary Labels: Provide to Owner those listed on Piping Schedule that do not receive arrows.

5. Application: To pipe only after painting in vicinity is complete or as approved by Engineer.

6. Installation: In accordance with manufacturer's instructions.

B. Equipment Labels:

1. Locate and Install: On equipment or concrete equipment base.

2. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

3.05 SIGN SCHEDULE

A. Sign Schedule following "END OF SECTION" is a tabulation of sign characteristics and mounting information for each sign shown by its "Mark" on Drawings, and is a part of this Specification.

B. Provide signs as scheduled.

C. Meet requirements of Federal Occupational Health Act (OSHA).

1. Close valve on truck hose.

3.06 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are part of this Specification.

1. 3 Sign Schedules.

2. 1 Mock-Up Plaque.

END OF SECTION

SIGN SCHEDULE – EQUIPMENT / OPERATIONS BUILDING & BASINS

SIGN							MOUNTING			LETTERING					OTHER REQUIREMENTS
Location	Qty	Type	Format	Maximum Size		Color	Location	Method	Height to Centerline	Height	Style	Color	Message	Faces	
				Width	Height										
Upper Level Bldg	1	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Control Room	1	Install on Door
Upper Level Bldg	1	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Mechanical Room	1	Install on Door
Upper Level Bldg	1	G	As specified	6”	6”	Gray	Door	Tape	5’ 0”	Symbol	Helvetica	Black	Unisex	1	Install on Door
Upper Level Bldg	2	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Electrical / MCC Room	1	Install on 2 Doors
Lower Level Bldg	1	A	As specified	12”	6”	Red/White	Wall	Bolts	5’ 6”	1”	Helvetica	Black	Danger High Voltage	1	As directed by Engineer
Lower Level Bldg	1	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Support Room	1	Install on West Personnel Door (Ext)
Lower Level Bldg	1	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Chemical Room	1	Install on West Personnel Door (Ext)
Lower Level Bldg	2	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Equipment Room	1	Install on 2 Personnel Doors (Int & Ext South)
Lower Level Bldg	1	H	Standard Hazmat	14”	10”	Red/White	Wall	Tape	5’6”	n/a	n/a	Black	Danger Sodium Hypochlorite	1	Install on Ext. of Chemical Room Door
Lower Level Bldg	1	H	Standard Hazmat	6”	6”	Standard Hazmat	Door	Tape	Below Window	n/a	n/a	Standard Hazmat	Corrosion Hazmat Symbol	1	As directed by Engineer
Various	10	B	Standard	20”	14”	Red/White	Chain	Hanging	Various	1”	Helvetica	Black	Non-potable Not for Drinking	1	As directed by Engineer
Lower Level Bldg	1	H	Standard Hazmat	14”	10”	Red/White	Wall	Tape	5’ 6”	n/a	n/a	Black	Danger Sodium Hydroxide	1	As directed by Engineer
Lower Level Bldg	1	Q	See Spec	18”	16”	Cast Bronze, see Spec	Wall	Rosette Screw	5’-6”		See Spec	Light Oxidized	See Spec	1	See Spec for details
Various	3	B	Standard	12”	6”	Blue/White	Wall		Various	1”	Helvetica	Black	Potable Water	1	As directed by Engineer

SIGN							MOUNTING			LETTERING					OTHER REQUIRE-MENTS
Location	Qty	Type	Format	Maximum Size		Color	Location	Method	Height to Centerline	Height	Style	Color	Message	Faces	
				Width	Height										
Centrifuge Building Exterior	1	A	As specified	12”	6”	Gray	Door	Tape	Below Window	1”	Helvetica	Black	Centrifuge Building	1	Install on Personnel Door
Centrifuge Building Interior Wall at Polymer Storage	1	H	Standard Hazmat	6”	6”	Standard Hazmat	Door	Tape	Below Window	n/a	n/a	Standard Hazmat	Corrosion Hazmat Symbol	1	As directed by Engineer
Centrifuge Building Interior Wall at Polymer Storage	2	H	Standard Hazmat	14”	10”	Red/White	Wall	Tape	5’ 6”	n/a	n/a	Black	Danger Polymer Storage	1	As directed by Engineer
Various	2	B	Standard	12”	6”	Blue/White	Wall	Hang	Various	1”	Helvetica	Black	Potable Water	1	As directed by Engineer
Centrifuge Bldg Interior	1	n/a	Standard	10”	7”	Red/Black White	on wall to right of man door	Bolt	5’-6”	Std	Standard	White / Black	DANGER FLAMMABLE	1	Standard Plastic Danger Sign
Centrifuge Bldg Interior	1	n/a	Standard	10”	7”	Yellow / Black	on wall to right of man door	Bolt	5’-6”	Std	Standard	Yellow / Black	CAUTION HIGH NOISE LEVEL AREA	1	Ear Protection Fiberglass Sign

SIGN SCHEDULE – OTHER PLANT AREAS

SIGN							MOUNTING			LETTERING					OTHER REQUIREMENTS
Location	Qty	Type	Format	Maximum Size		Color	Location	Method	Height to Centerline	Height	Style	Color	Message	Faces	
				Width	Height										
Plant Entrance Gates	2	A	As Specified	44”	24”	White	On chain link fence gate, as directed	Plastic ties on 4 corners	5’-6”	2”	Helvetica	Black	KIAWAH RIVER PLANTATION WASTEWATER TREATMENT FACILITY IN CASE OF EMERGENCY CALL 843-XXX-XXXX	1	Provide hole in each corner for attachment. Phone number to be provided upon ordering.
Holding Pond Entrance Gate	1	A	As Specified	44”	24”	White	On chain link fence gate, as directed	Plastic ties on 4 corners	5’-6”	2”	Helvetica	Black	KIAWAH RIVER PLANTATION WASTEWATER TREATMENT HOLD POND IN CASE OF EMERGENCY CALL 843-XXX-XXXX	1	Provide hole in each corner for attachment. Phone number to be provided upon ordering.

KIAWAH RIVER PLANTATION

WASTEWATER TREATMENT FACILITY

0.10 MGD MEMBRANE BIOREACTOR
(date of commissioning)

CONSULTING ENGINEER
Thomas & Hutton Engineering Co.
GENERAL CONTRACTOR
(to be determined)

DIVISION 26 – ELECTRICAL

260500 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.02 SUMMARY

A. This division of the Specifications, Division 16 000, covers the complete interior and exterior electrical systems as indicated on the drawings or as specified herein. Provide all materials, labor, equipment and supervision to install electrical systems.

1.03 QUALITY ASSURANCE

A. All electrical work shall be in accordance with the following codes and agencies:

1. The National Electrical Code (NFPA 70)
2. The National Electrical Safety Code (ANSI C-2)
3. The Life Safety Code (NFPA 101)
4. The International Building Code
5. Occupation Safety and Health Administration (OSHA)
6. Manufacturer’s written requirements.
7. Regulations of the local utility company with respect to metering and service entrance.
8. Municipal and state ordinances governing electrical work.

B. Material Standards: All material shall be new and shall conform to the standards where such have been established for the particular material in question. Publications and Standards of the organization listed below are applicable to materials specified herein.

1. American Society for Testing and Materials (ASTM)
2. Underwriters' Laboratories, Inc. (UL)
3. National Electrical Manufacturer Association (NEMA)
4. Insulated Cable Engineers Association (ICEA)
5. Institute of Electrical and Electronic Engineers (IEEE)
6. National Fire Protection Association (NFPA)
7. American National Standards Institute (ANSI)
8. Manufacturer’s Written Requirements

1.04 PERMITS

A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

1.05 WARRANTY

A. For warranty of work under Division 16, refer to the GENERAL CONDITIONS.

1.06 DRAWINGS

A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans unless indicated on Electrical plans.

C. Bring all discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Engineer.

D. Equipment layout is based on one manufacturer's product. Where equipment selected by the Contractor for use on the job differs from layout, the Contractor shall be responsible for coordinating space requirements and connection arrangements.

1.07 SUBMITTALS:

A. Shop Drawings and Product Data:

1. The Contractor shall submit for review by the Engineer data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment. Submittals for lighting fixtures shall include Photometric data.
2. Refer to the individual sections for identified equipment and materials for which submittals are required.
3. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES section for required procedures.

B. Record Documents

1. Refer to Division 1 for record documents and related submittals.

1.08 OPERATION AND MAINTENANCE DATA AND INSTRUCTIONS

A. Refer to Division 1 for detail requirements.

B. Printed Material: Provide required printed material for binding in operation and maintenance manuals.

C. Instructions of Owner Personnel:

1. Before final inspection, as designated by the Engineer provide a competent representative to instruct Owner's designated personnel in systems under this division of the specifications. For equipment requiring seasonal operation, perform instructions for other season within six months unless requested otherwise.
2. Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
3. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

1.09 EQUIPMENT REQUIRING ELECTRICAL SERVICE

A. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment requiring electrical service. Refer to ELECTRICAL CONNECTIONS FOR EQUIPMENT section for connection requirements.

B. Drawings indicate design loads and voltages and corresponding control equipment, feeders, and overcurrent devices. If equipment actually furnished have loads other than those indicated on the drawings or specified herein, control equipment, feeders, and overcurrent devices shall be adjusted in size accordingly at no additional cost to the Owner. Such adjustment shall be subject to the review of the Engineer.

C. Incidental items not indicated on Drawings or mentioned in Specifications but that can legitimately and reasonably be inferred to belong to the Work or be necessary in good practice to provide a complete system, shall be furnished and installed as though itemized here in detail. This includes connection requirements for air conditioning and refrigeration equipment as outlined by NEC Article 440.

1.10 MECHANICAL SYSTEMS INTERFACE

A. All control wiring for plumbing and heating, ventilating and air conditioning systems shall be installed under Division 16. Review Division 16 specifications and shop drawings for control systems to assure compatibility between equipment furnished under Division 16 and wiring furnished under Division 16.

B. Motor controllers (starters) shall be furnished and installed under Division 16, unless specified to be furnished as an integral component of the equipment. Provide the number and type of auxiliary contacts necessary to interlock the equipment and provide the specified control sequence.

C. Power wiring to all motors and motor controllers and between motors and controllers shall be provided in Division 16.

D. All electric heating equipment shall be provided and installed under Division 15 - HEATING, VENTILATING AND AIR CONDITIONING. Power wiring to all electric heating equipment shall be provided under Division 16 of these specifications.

1.11 SCHEDULING OF OUTAGES

A. Electrical work requiring interruption of electrical power which would adversely affect the normal operation of the other portions of the Owner's property, shall be done at time other than normal working hours. Normal working hours shall be considered eight A.M. to five P.M. Monday through Friday.

B. Schedule all work requiring interruption of electrical power two weeks prior to actual shutdown. Submit schedule in writing indicating extent of system to be de-energized, date and time when power is intended to be interrupted, and date and time power will be restored. Schedule shall be subject to the approval of the Engineer and the Representative of the Owner.

1.12 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems, shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project.

B. Verify the secondary service voltage of the buildings to be served and transmit written verification to the Engineer prior to submitting shop drawings or ordering any voltage rated materials for use in the buildings to be served.

PART 2 - BASIC MATERIALS

2.01 MATERIALS

A. All materials shall be new.

B. Furnish all materials specified herein or indicated on the drawings.

C. Materials of the same type shall be the product of one manufacturer.

D. All materials shall be UL listed and shall bear UL label. ETL listed material shall bear ETL label. ETL label shall be accepted in lieu of UL when the UL testing standards have been followed.

PART 3 - DISTRIBUTION PRODUCTS

3.01 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material. Handle materials in accordance with manufacturer's applicable standards and suppliers recommendations, and in a manner to prevent damage to materials. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact. Containers which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises.

B. All material, except items specifically designed to be installed outdoors such as pad mounted transformers or stand-by generators, shall be stored in an enclosed, dry building or trailer. Areas for general storage shall be provided by the Contractor. Provide temperature and/or humidity control where applicable. No material for installation, including conductors, shall be stored other than in an enclosed weathertight structure. Equipment stored other than as specified above shall be removed from the premises.

C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat and high humidity at all times. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

3.02 CLEANING AND PAINTING

A. Remove oil, dirt, grease and foreign materials from all raceways, fittings, boxes, panelboard trims and cabinets to provide a clean surface for painting. Touchup scratched or marred surfaces of lighting fixtures, panelboard and cabinet trims, motor control center, switchboard or equipment enclosures with paint furnished by the equipment manufacturers specifically for that purpose.

B. Do not paint trim covers for flush mounted panelboards, telephone cabinets, pull boxes, junction boxes and control cabinets unless required by the Engineer, National Electrical Code or other Sections of the specifications. Remove trim covers before painting. Under no conditions shall locks, latches or exposed trim clamps be painted.

C. Unless indicated on the drawings or specified herein to the contrary, all painting shall be done under the PAINTING Section of these Specifications.

D. Where plywood backboards are used to mount equipment provided under Division 16, paint backboards with two coats of light grey semi-gloss paint under Division 16.

3.03 EXCAVATION, TRENCHING AND BACKFILLING

A. Perform all excavation to install conduits, indicated on the drawings or specified herein. During excavation, pile material for backfilling back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. Provide shoring as required by OSHA Standards. Remove and dispose of all excavated materials not to be used for backfill. Grade to prevent surface water from flowing into trenches and excavation. Remove any water accumulating therein by pumping. Do all excavation by open cut. No tunneling shall be done unless indicated on the drawings or unless written permission is received from the Architect.

B. Grade the bottom of trenches to provide uniform bearing and support for conduits on undisturbed soil at every point along its entire length. Tamp overdepths with loose, granular, moist earth. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.

C. Backfill the trenches with excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones, deposited in 6" layers and rammed until the installation has a cover of not less than the adjacent ground but not greater than 2" above existing ground. Backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. Compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material. Do not settle backfill with water. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore surface to grade and compaction indicated on the drawings, mounded over and smoothed off.

3.04 ELECTRICAL SYSTEMS OPERATIONAL TESTS, MANUFACTURERS SYSTEMS CERTIFICATION AND DESIGN AUTHORITY ASSISTANCE.

A. Testing

1. Refer to the individual specification sections and the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of the specifications for test requirements.
2. Prior to the final inspection, the systems or equipment shall be tested and reported as therein specified. Five (5) typewritten copies of the tests shall be submitted to the Engineer for approval.
3. All electrical systems shall be tested for compliance with the specifications.

B. Manufacturers Certifications

1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been reviewed by the manufacturer is installed in accordance with the manufacturer's recommendations and is operating in accordance with the specifications.
2. Provide manufacturers certification for the following systems:
   a. Engine Driven EPSS.

C. Design Authority Assistance

1. The Contractor shall provide personnel to assist the Engineer or his representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, radios, etc.
2. Remove equipment covers (i.e. panelboard trims, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceilings shall be removed as directed for inspection of equipment installed above ceilings.
3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment and systems as directed by the Representative.

4. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Engineer compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the Engineer. Refer to the specific specification section for additional testing requirements. Representatives of the following systems are required for demonstrations:
   a. Engine Driven EPSS

END OF SECTION

DIVISION 26 – ELECTRICAL

260519 – WIRES AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of furnishing, installation and connections of the building wiring system, 600 volts and below. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. Wiring systems for communication and alarm systems are not included in this section unless specified to be included, by reference, in the respective specification sections for alarm and communication systems.

1.03 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 44: Rubber - Insulated Wire and Cables
   b. No. 83: Thermoplastic - Insulated Wires
   c. No. 493: Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
   d. No. 486: Wire Connectors and Soldering Lugs
2. Insulated Cable Engineers Association Standards (ICEA):
   a. S-61-402: Thermoplastic Insulated Wire and Cable
3. National Electrical Manufacturer's Standards (NEMA):
   a. WC-5: Thermoplastic Insulated Wire and Cable
4. National Fire Protection Association Publication (NFPA):
   a. No. 70: National Electrical Code (NEC)
5. Federal Specifications (Fed. Spec.):
   a. J-C-30A(1) Cable and Wire Electrical (Power Fixed Installations)
   b. HH-I-595C: Insulation Type, Electrical, Pressure-Sensitive Adhesive, Plastic

B. Acceptable Manufacturers. Products produced by the following manufacturers which conform to this specification are acceptable.

1. Hydraulically applied conductor terminations:
   a. Square D
   b. Burndy

c. Ilsco
d. Scotch (3M)
e. Thomas and Betts (T&B)
f. Anderson

2. Mechanically applied (crimp) conductor terminations:
   a. Scotch (3M)
   b. Ideal
   c. Thomas and Betts (T&B)
   d. Burndy
3. Vinyl electrical insulating tape:
   a. Scotch (3M)
   b. Tomic
   c. Permacel
4. Twist-On Wire Connectors:
   a. Scotch (3M)
   b. Ideal
   c. Buchanan
5. Encapsulated insulating kits:
   a. Scotch (3M)
   b. Raychem
   c. Essex Group, Inc.
6. Portable cable fittings:
   a. Crouse Hinds
   b. Appleton
   c. T&B
7. Insulated cable:
   a. Brand-Rex Co.
   b. Cablec Corp.
   c. The Okonite Co.
   d. Pirelli Cable Corp.
   e. Senator Wire and Cable Co.
   f. Southwire Co.
   g. Alpha Wire and Cable
   h. Lapp Wire and Cable
   i. Houston Wire & Cable Co.
   j. Aetna Insulated Wire Co.
   k. American Insulated Wire Corp.
   l. Belden

C. Performance: Conductors shall be electrically continuous and free from short circuits or grounds. All open, shorted or grounded conductors and any with damaged insulation shall be removed and replaced with new material free from defects.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Provide all materials under this section of the specifications.

B. All wire and cable shall be UL listed and shall bear a UL label along the conductor length at intervals not exceeding 24 inches.

C. All conductors shall have size, grade of insulation, voltage and manufacturer's name permanently marked on the outer cover at intervals not exceeding 24 inches.

D. Conductor size shall be a minimum of No. 12 AWG. Conductor size shall not be less than indicated on the drawings.

E. Insulation voltage level rating shall be 600 volts.

2.02 PRODUCT/MATERIALS DESCRIPTION

A. Conductors No. 10 AWG and smaller shall be solid copper, 90°C. type THHN, THWN or XHHW unless otherwise indicated on the drawings, required by the National Electrical Code, or specified elsewhere in Division 16. Where fixtures are used as raceway use 90°C type THHN or XHHN conductors.

B. Conductors larger than No. 10 AWG shall be stranded copper, 90°C,, type THHN/THWN, XHHW, unless otherwise indicated on the drawings, required by the National Electrical Code, or specified herein.

C. Fixture wire shall be No. 16 AWG silicone rubber insulated, stranded fixture wire, type SFF-2 (150°C), or No. 16 AWG thermoplastic, nylon jacketed stranded fixture wire, type TFFN (90°C). Color code as specified herein shall not be required for fixture wire; however, neutral conductor shall be identified distinctly from phase conductors.

D. Control conductors for use on 120 volt control wiring systems shall be No. 12 AWG stranded type THHN/THWN, unless indicated otherwise on the drawings.

E. Splices and taps (No. 10 AWG and smaller) - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600 volt, 105°C. with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.

F. Splices and taps (No. 8 and larger) - Hydraulically applied crimping sleeve or tap connector sized for the conductors or indent, split-bolt or bolt clamp-type connectors. Insulate the hydraulically applied connector with 90°C., 600 volt insulating cover provided by the connector manufacturer. Insulate the mechanically applied connectors with heat shrink insulator sleeve or plastic electrical insulating type. Insulator materials and installation shall be approved for the specific application, location, voltage and temperature and shall not have an insulation value less than the conductors being joined.

G. Electrical insulating tape shall be 600 volt, flame retardant, cold and weather resistant, minimally .85 mil thick plastic vinyl material; Scotch No. 88, Tomic No. 85, Permacel No. 295.

2.03 VFD CABLE

A. All feeders for motors controlled by variable frequency drives shall be served with cable specifically manufactured to mitigate the EMI and RFI effects on adjacent cables and/or conductors.

B. Acceptable manufacturers: Lapp Group USA, Belden and Alpha Wire.

C. Required characteristics for VFD power cable:

1. Class B stranded copper or tinned copper conductors with XLP/XLPE insulation.
2. Three bare copper ground conductors or integral with the cable.
3. Spiral or helical copper tape for 100% shield.
4. 1000V minimum rating.
5. 90°C, wet or dry installation, approved for direct burial, TC-ER approved.
6. PVC outer jacket.

PART 3 - EXECUTION

3.01 EXECUTION

A. Install all wiring in raceway system.

B. Connect all conductors. Torque each terminal connection to the manufacturers recommended torque value. A calibrated torqueing tool shall be used to insure proper torque application. Any conductors nicked or ringed while removing insulation shall be replaced.

C. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three branch circuits are to be installed in any one conduit, on 3 phase 4 wire system, unless specifically indicated otherwise on the drawings. A maximum of two branch circuits are to be installed in any one conduit, on 1 phase 3 wire systems, unless specifically indicated otherwise on the drawings. No two

branch circuits of the same phase are to be installed in the same conduit, unless specifically indicated on the drawings.

D. Conductors shall be tested to be continuous and free of short circuits and grounds.

E. Identification

1. Conductors within pull boxes shall be grouped and identified with nylon tie straps with circuit identification tag.
2. Identify each control conductor at its terminal points with wrap around tape wire markers. I.D. to indicate terminal block and point designation, or other appropriate identifying indication.
3. Refer to ELECTRICAL IDENTIFICATION section of these specifications for additional identification requirements.

F. Color Code Conductors.

1. Color code all secondary service, feeder and branch circuit conductors. Control and signal system conductors need not be color coded.
2. Coding shall be as follows:
   a. 208Y/120 volt three phase four wire wye system - Phase A: Black, Phase B: Red, Phase C: Blue, Neutral: White
   b. 480Y/277 volt three phase four wire system - Phase A: Brown, Phase B: Orange, Phase C: Yellow, Neutral: Gray
   c. 240/120 volt single phase 3 wire system - Phase A: Black, Phase B: Red, and Neutral: White
3. Grounding conductors shall be green.
4. Conductors No. 6 and smaller shall have solid color compound insulation or continuous color finish. Conductors No. 4 and larger shall have colored phase tape. Colored tape shall be installed on conductors in every box, at each terminal point, cabinet, through manhole or other enclosure.

G. Maintain phase rotation established at service equipment throughout entire project.

H. Group and lace with nylon tie straps all conductors within enclosures, i.e. panels, motor controllers, motor control center, switchboard, switchgear, terminal cabinets and control cabinets.

I. Make splices in conductors only within junction boxes. Do not splice conductors in pull boxes, panelboards, safety switches, switchboard, switchgear, motor control center, wiring troughs or motor control enclosures.

J. Terminate conductors No. 10 AWG and smaller specified in Division 16 to be stranded, with crimp type lug or stud. Direct termination of stranded conductors without crimp terminator to terminal screws, lugs, or other points is not permitted even if terminal is rated for stranded conductors. Crimp terminal shall be the configuration type suitable for terminal point. Crimp lugs shall be applied in strict accordance with the manufacturer's written requirements.

K. Make connections between fixture junction box and fixture with fixture wire.

L. Control, communications or signal conductors shall be installed in separate raceway systems from branch circuit or feeder raceway, unless indicated otherwise on the drawings.

M. Splices in conductors installed below grade are not permitted.

END OF SECTION

DIVISION 26 – ELECTRICAL

260526 – SECONDARY GROUNDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of furnishing, installation and connections of the building secondary grounding systems. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. The building electrical system shall be a 3 phase, 4 wire grounded wye system supplemented with equipment grounding system. Equipment grounding system shall be established with equipment grounding conductors; the use of metallic raceways for equipment grounding is not acceptable.

1.03 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 44: Rubber - Insulated Wire and Cables
   b. No. 83: Thermoplastic - Insulated Wires
   c. No. 467: Electrical Grounding and Bonding Equipment
   d. No. 493: Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
   e. No. 486: Wire Connectors and Soldering Lugs
2. National Electrical Manufacturer's Standards (NEMA):
   a. WC-5: Thermoplastic Insulated Wire and Cable
   b. WC-7: Cross-Linked-Thermosetting Polyethylene Insulated Wire and Cable
3. National Fire Protection Association Publication (NFPA):
   a. No. 70: National Electrical Code (NEC)

B. Acceptable Manufacturers. Products produced by the following manufacturer which conform to this specification are acceptable.

1. Hydraulically applied conductor terminations:
   a. Square D
   b. Burndy
   c. Ilsco

d. Scotch (3M)
e. Thomas and Betts (T & B)
f. Anderson

2. Mechanically applied (crimp) conductor terminations:
   a. Scotch (3M)
   b. Ideal
   c. Thomas and Betts (T & B)
   d. Burndy
3. Exothermic connections:
   a. Cadweld

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Provide all materials under this section of the specifications. All materials shall be new.

B. All materials shall be UL listed and bear a UL label.

C. Refer to the specific specification section for the description and requirements of materials mentioned herein for installation.

2.02 GROUNDING CONDUCTORS

A. Grounding electrode conductor shall be bare or green insulated copper conductor sized as indicated on the drawings.

B. Equipment grounding conductors shall be green insulated type THW, THWN, or XHHN conductors sized as indicated on the drawings. Where size is not indicated on the drawings, conductor size shall be determined from the National Electrical Code table on sizes of equipment grounding conductors.

C. Bonding jumpers shall be flexible copper bonding jumpers sized in accordance with the National Electrical Code tables for grounding electrode conductors.

2.03 TRANSFORMERS, MOTOR CONTROLLERS, AND DISCONNECT SWITCHES

A. Provide a conductor termination grounding lug bonded to the enclosure of each equipment item.

2.04 DEVICES

A. Each receptacle and switch device shall be furnished with a grounding screw connected to the metallic device frame.

2.05 GROUND RODS

A. Ground rods shall be 3/4" x 10'-0" copper clad steel.

B. Sectional ground rods shall be hot dip galvanized 5/8" x 10' sections with an internal stainless steel splined coupling pin.

2.06 OTHER MATERIALS

A. Ground bus shall be solid copper, 1/4" thick x 2" x 24", tapped and drilled for conductor termination lug connections.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Ground all non-current carrying parts of the electrical system, i.e., wireways, equipment enclosures and frames, junction and outlet boxes, machine frames and other conductive items in close proximity with electrical circuits, to provide a low impedance path for potential grounded faults.

B. Service entrance and separately derived electrical systems, grounding electrode system.

1. The neutral conductor of the electrical service serving the premises wiring system shall be grounded to the ground bus bar in the service equipment which shall be grounded to the cold water system, the ground rod system, and other grounding electrodes specified herein or indicated on the drawings. Grounding electrode conductors shall be installed in rigid, non-metallic conduit to point of ground connection, unless subject to physical damage in which case they shall be installed in galvanized rigid steel. Where metallic conduit is permitted, bond conduit at both ends to grounding electrode conductor with a UL bonding bushing.
2. Make connection to main water line entering the building. Make connections ahead of any valve or fittings whose removal may interrupt ground continuity. Install a bonding jumper of the same size as the grounding conductor around the water meter.
3. Bond together the following systems to form the grounding electrode system. All system connections shall be made as close as possible to the service entrance equipment and each connected at the service entrance equipment ground bus. Do not connect electrode systems together except at ground bus.
   a. Cold water piping system
   b. Ground rod system
   c. Main rebar in a foundation footing, for a concrete structure

4. Ground the neutral of all dry type transformers to building steel which shall serve as the grounding electrode for the separately derived system. In reinforced concrete structures building steel shall be considered to be reinforcing steel of vertical columns. Make connection to building steel with an exothermic weld in a location in unfinished space where the connection will not be subject to physical abuse.
5. Ground the neutral and frame of the emergency generator to building steel and the ground rod system, which shall serve as the grounding electrode for the separately derived system. In reinforced concrete structures building steel shall be considered to be reinforcing steel of vertical columns. Make connection to building steel with an exothermic weld in a location in unfinished space where the connection will not be subject to physical abuse.
6. Grounding electrode connections to structural steel, reinforcing bars, ground rods, or where indicated on the drawings shall be with chemical exothermic weld connection devices recommended for the particular connection type. Connections to piping shall be with UL listed mechanical ground clamps.
7. Where more than one service serves a building or interconnected buildings, connect each service equipment ground bus together with a #4/0 copper conductor in PVC conduit.
8. Bonding shall be in accordance with the National Electrical Code.
9. Install ground rods where indicated on the drawings with the top of the ground rods 12" below finished grade.

C. Equipment Grounding Conductor

1. Grounding conductors for branch circuits are not shown on the drawings; however, grounding conductors shall be provided in all branch circuit raceways and cables. Grounding conductors shall be the same AWG size as branch circuit conductors.
2. Grounding conductors for feeders are typically indicated on the drawings and the raceway is sized to accommodate grounding conductor shown. Where grounding conductor size is not indicated on the drawings, conductor shall be in accordance with the equipment grounding conductor table of the National Electrical Code.
3. A grounding conductor shall be installed in all flexible conduit installations. For branch circuits, grounding conductor shall be sized to match branch circuit conductors.
4. A feeder serving several panelboards shall have a continuous grounding conductor which shall be connected to each related cabinet grounding bar.
5. The equipment grounding conductor shall be attached to equipment with bolt or sheet metal screw used for no other purpose. Where grounding conductor is stranded, attachment shall be made with lug attached to grounding conductor with crimping tool.

6. Ground all motors by drilling and tapping the bottom of the motor junction box and attaching the equipment grounding conductor to the box with a round head bolt used for no other purpose. Conductor attachment shall be through the use of a lug attached to conductor with crimping tool.
7. Equipment grounding conductors shall terminate on panelboard, switchboard, or motor control center grounding bus only. Do not terminate on neutral bus. Provide a single terminals lug for each conductor. Conductor shall terminate in the same section as the phase conductors originate. Do not terminate neutral conductors on the ground bus.

D. Other Grounding Requirements

1. Each telephone backboard shall be provided with a No. 6 grounding conductor. When backboard is located in vicinity of electrical service equipment, the "point of grounding" of this conductor shall be the main cold water service with connections made ahead of any valves or joints. Remote backboards shall use building steel as "point of grounding". Terminate conductor by stapling to backboard.
2. At each building expansion joint flexible copper bonding jumpers shall be attached to building structure by exothermic weld process. Install bonding jumpers in concealed locations that will not subject connections or jumpers to physical abuse. Install 100' on centers across expansion joints.
3. Lighting fixtures shall be grounded with a green insulated ground wire secured to the fixture with a UL listed bond lug, screw, or clip specifically made for such use.

3.02 TESTING

A. Upon completion of the ground rod installation, the Contractor shall test the installation in accordance with the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification. Grounding resistance reading shall be taken before connection is made to the building cold water piping system. Ground resistance readings shall not be taken within forty-eight hours of rainfall. Results of ground resistance readings shall be forwarded, in writing, immediately to the Architect.

END OF SECTION

DIVISION 26 – ELECTRICAL

260529 – SUPPORTING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Extent of supports, anchors, sleeves and seals is indicated by drawings and schedules and/or specified in other Division - 16 sections.

B. Types of supports, anchors, sleeves and seals specified in this section include the following:

1. Clevis hangers.
2. Riser clamps.
3. C-clamps.
4. I-beam clamps.
5. One-hole conduit straps.
6. Two-hole conduit straps.
7. Round steel rods.
8. Expansion anchors.
9. Toggle bolts.
10. Wall and floor seals.

C. Supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment are specified as part of that equipment assembly in other Division - 16 sections.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.

B. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

C. UL Compliance: Provide electrical components which are UL-listed and labeled.

D. FS Compliance: Comply with Federal Specification FF-S-760 pertaining to retaining straps for conduit, pipe and cable.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve and seal.

PART 2 - PRODUCTS

2.01 MANUFACTURED SUPPORTING DEVICES

A. General: Provide supporting devices which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Installer's option.

B. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

1. Clevis Hangers: For supporting 2" rigid metal conduit; galvanized steel; with 1/2" diameter hole for round steel rod; approximately 54 lbs. per 100 units.
2. Reducing Couplings: Steel rod reducing coupling, 1/2" x 5/8"; black steel; approximately 16 lbs. per 100 units.
3. C-Clamps: Black malleable iron; 1/2" rod size; approximately 70 lbs. per 100 units.
4. I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock; 3/8" cross bolt; flange width 2"; approximately 52 lbs. per 100 units.
5. One-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; approximately 7 lbs. per 100 units.
6. Two-Hole Conduit Straps: For supporting 3/4" rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
7. Hexagon Nuts: For 1/2" rod size; galvanized steel; approximately 4 lbs. per 100 units.
8. Round Steel Rod: Black steel; 1/2" diameter; approximately 67 lbs. per 100 feet.
9. Offset Conduit Clamps: For supporting 2" rigid metal conduit; black steel; approximately 200 lbs. per 100 units.

C. Anchors: Provide anchors of types, sizes and materials indicated, with the following construction features:

1. Toggle Bolts: Springhead; 3/16" x 4"; approximately 5 lbs. per 100 units.
2. Expansion sleeve anchors by Hilti or Phillips Redhead: 1/2"; approximately 38 lbs. per 100 units.

3. Manufacturers: Subject to compliance with requirements, provide anchors of one of the following:
   a. Ackerman Johnson Fastening Systems Inc.
   b. Hilti
   c. Ideal Industries, Inc.
   d. Joslyn Mfg and Supply Company
   e. McGraw Edison Company
   f. Phillips Redhead
   g. Rawlplug Company Inc.

D. Sleeves and Seals: Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:

1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

E. Conduit Cable Supports: Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct for 2" rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

F. U-Channel Strut Systems:

1. Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" diameter holes, 8" o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U-channel. Provide 304 stainless steel U-channel for all exterior installations.
   a. Fixture hangers.
   b. Channel hangers.
   c. End caps.
   d. Beam clamps.
   e. Wiring studs.
   f. Thinwall conduit clamps.
   g. Rigid conduit clamps.
   h. Conduit hangers.
   i. U-bolts.
2. Manufacturers: Subject to compliance with requirements, provide channel systems of one of the following:
   a. Allied Tube and Conduit Corporation.
   b. B-Line Systems, Inc.
   c. Elcen Metal Products Company.
   d. Greenfield Mfg Company, Inc.
   e. Midland-Ross Corporation.

f. OZ/Gedney Div; General Signal Corporation.
g. Power-Strut Div; Van Huffel Tube Corporation.
h. Unistrut Div; GTE Products Corporation.

2.02 FABRICATED SUPPORTING DEVICES

A. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal: 3" and smaller, 20-gage; 4" to 6", 16-gage; over 6", 14" gage.
2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Iron Pipe: Fabricate from cast-iron or ductile-iron pipe.
4. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

B. Sleeve Seals: Provide modular mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.01 INSTALLATION OF SUPPORTING DEVICES

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports in compliance with NEC requirements.

D. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.

E. Remove burrs from ends of pipe sleeves.

END OF SECTION

DIVISION 26 – ELECTRICAL

260533 – RACEWAYS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section covers the complete interior and exterior raceway system.

B. Definition: The term conduit, as used in this Specification, shall mean any or all of the raceway types specified.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standard: The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   - No. 1 Flexible Metal Electrical Conduit
   - No. 6 Rigid Galvanized Conduit
   - No. 467 Electrical Grounding and Bonding
   - No. 651 Rigid Nonmetallic Electrical Conduit
   - No. 797 Electrical Metallic Tubing
   - No. 1242 Intermediate Metal Conduit
2. American National Standards Institute (ANSI):
   - C-80.1 Rigid Galvanized Conduit.
   - C-80.3 Electrical Metallic Tubing.
3. National Fire Protection Association (NFPA):
   - No. 70 National Electrical Code (NEC).
4. Federal Specifications (Fed Spec):
   a. WW-C-540A: Conduit, Metal, Rigid (Electrical Aluminum).
   b. WW-C-581E: Conduit, Metal, Rigid; And Couplings, Elbow and
   c. Nipple, Electrical Conduit: Zinc Coated.
   d. W-C-1094A: Conduit and Conduit Fittings Plastic, Rigid.

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. Metallic Conduit Fittings:
   a. Appleton
   b. Carlon
   c. Crouse Hinds
   d. Killark
   e. O-Z/Gedney
   f. RACO
   g. Thomas and Betts
2. Support Channel:
   a. Kindorf
   b. Powers
   c. Unistrut
3. Non-Metallic Conduit and Fittings:
   a. Carlon
   b. Certainteed
   c. Thomas and Betts

C. Coordination

1. Coordinate conduit installation with electrical equipment furnished.
2. Coordinate conduit installation with contract documents and other contractors. Adjust installation to eliminate conflicts. Review all shop drawings submitted under this and other sections to insure coordination with all equipment requiring electrical service and to avoid conflict interferences. Coordinate installation sequence with other contractors to avoid conflicts including equipment access and provide the fastest overall installation schedule.

1.04 STORAGE AND HANDLING

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section of the specifications for storage and handling requirements.

B. Non-metallic conduits stored on site prior to installation shall be stored on a surface off of the ground and shall be protected from the direct rays of the sun and from debris.

C. Damaged, oxidized, warped, improperly stored material or material with excessive amounts of foreign debris will be removed from the project and replaced with new materials.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All conduit and fittings shall be listed and bear a label by Underwriters' Laboratories (UL) for use as raceway system for electrical conductors.

C. Raceway is required for all wiring, unless specifically indicated or specified otherwise.

D. Size: The minimum size of conduit shall be 3/4". The size of all conduits shall be in accordance with the NEC, but, not less than indicated on the drawings.

2.02 EMT CONDUIT FITTINGS

A. Electrical Metallic Tubing (EMT) couplings and connectors shall be steel "concretetight" type. Malleable iron, die cast or pressure cast fittings are not permitted. Fittings 2.0" and smaller shall be gland and ring compression type. Connectors for conduits 2.5" and larger shall be set screw type with two (2) screws each or compression type. Couplings for conduits 2.5" and larger shall be set screw type with four (4) screws each or compression type. All connectors shall be insulated throat type. All set screw connectors encased in walls or floor shall be taped at all joints.

2.03 RIGID AND IMC CONDUIT FITTINGS

A. Fittings for rigid steel and IMC shall be standard threaded couplings, threaded hubs and elbows. All materials shall be steel or malleable iron only. Set screw or non-thread fittings are not permitted. Bushings shall be metallic insulating type consisting of insulating insert molded or locked into the metallic body of the fittings. Erickson-type couplings may be used to complete a conduit run.

2.04 NON-METALLIC CONDUIT AND FITTINGS

A. Non-metallic conduit shall be schedule 80 PVC.

B. Non-metallic conduit fittings shall be of the same material as the conduit furnished and be the product of the same manufacturer.

C. Glue for all non-metallic conduit and fittings shall be provided as required by the manufacturer of the conduit being used.

2.05 CONDUIT SUPPORTS

A. All parts and hardware shall be zinc-coated or have equivalent corrosion protection.

B. Conduit straps shall be single hole cast metal type or two hole galvanized metal type.

C. Conduit support channels shall be 1.5" x 1.5" x 14 gauge galvanized (or with equivalent treatment) channel. Channel suspension shall be 3/8" threaded steel rods. Use swivel type connector to attach suspension rods to structure. Spring steel clips are not acceptable. Wire or chain is not acceptable for conduit hangers. Stainless steel channels, fasteners and conduit straps shall be used on all exterior installations.

D. Individual conduit hangers shall be galvanized spring steel specifically designed for the purpose, sized appropriately for the conduit type and diameter, and have pre-assembled closure bolt and nut and provisions for receiving threaded hanger rod. Support with 1/4" threaded steel rod for individual conduits 1.5" and smaller and 3/8" rod for individual conduits 2.0" and larger.

E. Refer to SUPPORTING DEVICES section of these specifications for additional material requirements.

2.06 FLEXIBLE CONDUIT AND FITTINGS

A. Flexible conduit shall be steel metallic type. Where specified herein, indicated on the drawings, or when used in damp or wet locations, as classified by the National Electrical Code, flexible conduit shall be liquid tight.

B. All flexible conduit shall be classified as suitable for system grounding. All flexible (liquid tight) conduits shall be UL listed as sunlight (UV) resistant.

C. Connectors for flexible conduit shall be steel insulated throat type rated as suitable for system ground continuity. Connectors for liquid tight flexible conduit shall be screw-in ground cone type.

D. Flexible conduit shall not be less than 3/4" trade size and in no case shall flexible conduit size be less than permitted by the National Electrical Code for the number and size of conductors to be installed herein.

2.07 MISCELLANEOUS CONDUIT FITTINGS AND ACCESSORIES

A. Vinyl all weather electrical tape for corrosion protection shall be Scotch Temflex

B. Expansion and deflection couplings shall be in accordance with UL 467 and UL 514. They shall accommodate 3/4" deflection, expansion, or contraction in any direction and shall allow 30 degree angular deflections. Couplings shall contain an internal flexible metal braid to maintain raceway system ground continuity.

C. Fire and smoke stop materials shall be rock wool fiber, silicone foam, or silicone sealant, UL rated to maintain the fire floor or fire wall partition rating.

2.08 RIGID ALUMINUM CONDUIT FITTINGS

A. Rigid aluminum conduit fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be compatible with aluminum conduit of malleable iron, steel or aluminum alloy. Iron or steel fittings shall be zinc or cadmium plated. Aluminum fittings shall not contain more than 0.4 percent copper. Threaded hubs shall be as specified for rigid steel and IMC conduit. Set screw fittings or no-thread fittings are not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Conceal all conduits, except in unfinished spaces such as equipment rooms or where indicated by symbol on the drawings.
2. Leave all empty conduits with a 200 pound test nylon cord pull line.
3. Install as complete raceway runs prior to installation of cables or wires.
4. Flattened, dented, burned, or deformed conduits are not permitted and shall be removed and replaced.
5. Secure rigid conduit i.e., rigid galvanized conduit, rigid aluminum conduit and intermediate metal conduit, to sheet metal enclosures with threaded hubs. Secure EMT to sheet metal enclosures with insulated throat connectors with lock nut.
6. Fasten conduit support device to structure with wood screws on wood, toggle bolts on hollow masonry, anchors as specified on solid masonry or concrete, and machine bolts, clamps, or spring steel clips, on metal studs. Nails are not acceptable.
7. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until all masonry is complete. Protect conduit stub-ups during construction from damage; any damaged conduits shall not be used.
8. Seal all conduits originating from outside building from below grade and all conduits entering exterior mounted electrical equipment with insulating electrical putty to prevent entrance of moisture. Spray foam is not acceptable.
9. Install conduit with wiring, including homeruns as indicated on the drawings. Any change resulting in a savings in labor or materials is to be made only in accordance with a contract change. Deviations shall be made only where necessary to avoid interferences and when approved by Engineer by written authorization.

10. Use flexible conduit for connection to vibrating equipment and rotating machinery and for connection from junction box to flush mounted lighting fixtures only.
11. Separate raceway systems are to be installed for power systems and for control, signal and communications systems. Do not install control, signal or communications cables in the same raceways as branch circuit or feeder cables, unless indicated otherwise on the drawings.
12. Provide expansion fitting in all conduits where length of run exceeds 200 feet or where conduits pass building expansion joints.

B. Uses Permitted

1. Conduits installed within concrete floor slabs which are in direct contact with grade or other material shall be galvanized rigid steel (GRS) or intermediate metal conduit (IMC). Conduits which penetrate the building roof shall be galvanized rigid steel (GRS) or intermediate metal conduit (IMC). Conduits installed within concrete floor slabs which are above grade shall be galvanized rigid steel (GRS), intermediate metal conduit (IMC), or schedule 80 Heavy Wall PVC. Where transition is made from raceway in slab to any type of raceway out of slab, make transition with rigid galvanized elbow. For corrosion protection, where elbow penetrates surface, apply two coats of Scotchrap pipe primer and two overlapping layers of Scotchrap Temflex tape, for 6" above and below concrete surface.
2. Conduits installed in direct contact with earth shall be schedule 80, heavy wall PVC.
3. Service entrance conduits in direct contact with earth shall be galvanized steel. Other conduit in direct contact with earth shall be schedule 80, heavy wall PVC.
4. All other conduit, unless excluded herein, not permitted in accordance with the National Electrical Code, or otherwise indicated on the drawings, shall be electrical metallic tubing (EMT).
5. Conduit types shall not be mixed indiscriminately with other types in the same run, unless specified herein or required by the NEC.
6. Use flexible conduit for connections to motors, dry type transformers and unit heaters.
    a. Flexible conduit used for connection of motors, dry type transformers, electric duct heaters, unit heaters, busway tap devices and voltage regulators shall not exceed 18" in length.
    b. Maintain ground continuity through flexible conduit with green equipment grounding conductor; do not use flexible conduit for ground continuity.
    c. Liquid tight conduit shall be used to connect equipment in mechanical equipment rooms and exterior installations.
7. Service entrance and feeder conduits installed exposed or concealed in walls or above ceilings shall be galvanized rigid steel (GRS) or intermediate metal conduit (IMC). Service entrance conduits shall be installed "outside" of the building as defined by the NEC. Provide concrete encasement where required.

8. No conduit requiring cutting of cross-webs of concrete masonry units is permitted. Conduit shall be threaded through cells or concrete masonry units lowered around conduit. Neither horizontal joint reinforcement nor bond beam reinforcement shall be cut for conduit installation. Conduits shalal not be run horizontally in walls.
9. Rigid aluminum conduit may be used for all trade sizes 3.0" and larger for conduits not installed in concrete slabs, not installed in direct contact with earth, not installed in hazardous locations as defined by Article 500 of the National Electrical Code and not installed in areas exposed to excessive moisture.
10. All conduits installed exposed from the finished floor to a minimum height of 10 ft. above the floor shall be galvanized rigid steel (GRS) or intermediate metallic conduit (IMC).
11. Where hazardous locations, as classified by the National Electrical Code, exist, all conduits and fittings and the installation of these materials shall comply with Article 500 of the National Electrical Code.

C. Below Grade Raceway Installations

1. Direct Burial Conduit
   a. Install top of conduits 24" minimum below finished grade. Maximum depth shall be 36".
   b. Install top of conduits 6" minimum below bottom of building slabs.
   c. Install top of conduits 30" minimum below grade, below roads and any other paved surfaces.
   d. Where transition is made from below grade PVC installation to a metallic conduit system above grade or slab, make transition with rigid galvanized elbow and extend through slab or above grade with galvanized rigid steel conduit. For corrosion protection, where the elbow penetrates surface, apply two coats of Scotchrap pipe primer and two overlapping layers of Scotchrap Temflex tape, for 6" above and below concrete surface.
   e. For excavation and backfilling, refer to earthwork specification section.
   f. Conduit shall be run following the most direct route between points.

D. Raceway Installations Within Concrete

1. Conduit shall be run following the most direct route between points.
2. Conduit shall not be installed in concrete which is less than 3" thick or where the outside diameter is larger than 1/3 of the slab thickness.
3. Conduits installed in concrete slabs shall be buried in the concrete slab. Wire low conduits to upper side of the bottom reinforcing steel, and upper conduits to the lower side of the top reinforcing steel. Separate parallel runs of conduits within slab by at least 1".
4. Conduits shall not be installed within shear walls unless specifically indicated on the drawings. Conduits shall not be run directly below and parallel with load bearing walls

5. Protect each metallic conduit installed in concrete slab or conduits 1.5" and smaller passing through a concrete slab against corrosion where conduit enters and leaves concrete by wrapping conduit with vinyl all-weather electrical tape.
6. The maximum projection of conduit stub-up and bushing above slab shall be 3" in equipment rooms.
7. Protect all conduits entering and leaving concrete floor slabs from physical damage during construction.

E. Concealed (Above Ceilings and in Walls) and Exposed Raceway Installation

1. Conduit shall be run parallel or at right angles to existing walls, ceilings, and structural members.
2. Support branch circuit conduits at intervals not exceeding 10 ft. and within three feet of each outlet, junction box, cabinet or fitting. Attach individual branch circuit conduits to structural steel members with beam conduit clamps and to non-metallic structural members with one hole conduit straps. For exposed conduits and where conduits must be suspended below structure, single conduit runs shall be supported from structure by hangar rod and conduit clamp assembly. Multiple conduits shall be supported by trapeze type support suspended from structure. Do not attach conduits to ceiling suspension system channels or suspension wires.
3. Attach feeder conduits larger than 1" trade diameter to or from structure on intervals not exceeding 12 ft. with conduit beam clamps, one hole conduit straps or trapeze type support in accordance with support systems described for branch circuit conduits.
4. Where conduits must pass through structural members, obtain approval of Engineer with respect to location and size of hole prior to drilling.
5. Install conduit sleeves in slabs where conduits 2.0" and larger pass through. Sleeves shall extent 1" minimum above finished slab. Seal all spare sleeves and between conduits and sleeves to make watertight.
6. Seal all conduit penetrations, sleeves and conduits penetrating chemical room walls and ceilings to prevent the migration of hazardous gases.
7. Conduits rigidly secured to building construction on opposite sides of a building expansion joint shall be provided with an expansion and deflection coupling. In lieu of an expansion coupling, conduits 2-1/2" and smaller may be provided with junction boxes on both sides of the expansion joint connected by 15" of slack flexible conduit with bonding jumper.

3.02 ADJUSTMENT, CLEANING AND PROTECTION

A. Clean: Upon completion, clean all installed materials of paint, dirt, and construction debris. All conduit systems shall be cleaned of water and debris prior to the installation of any conductors.

END OF SECTION

DIVISION 26 – ELECTRICAL

260533.01 – BOXES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of the installation of outlet boxes, pull boxes, and junction boxes throughout the wiring system including box supports.

B. Definition: Box, as used in this specification, includes all outlet, device, junction, and pull boxes. Feeder shall mean all conductor circuits larger than #8 AWG, including service entrance conductors, and all wiring above 600V.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standards: The following specifications and standards are incorporated into and become a part of this specification by reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 50: Electrical Cabinets and Boxes
   b. No. 467: Electrical Grounding and Bonding Equipment
   c. No. 514: Electrical Outlet Boxes and Fittings
2. National Fire Protection Association (NFPA):
   a. No. 70: National Electrical Code (NEC)

B. Coordination: Review architectural drawings for areas where outlets occur within specific architectural or structural features and install outlets as shown on architectural drawings; or if not shown, accurately center and align boxes within the architectural features or detail.

C. Acceptable Manufacturers:

1. Exterior junction or pull boxes:
   a. Quaztite: Type PG
   b. Old Castle Synertech
   c. Penecel

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All boxes shall be UL listed and labeled.

C. Boxes shall be galvanized steel sheet metal, unless rustproof cast metal is specified or required by the NEC, or unless otherwise specified or indicated on the drawings.

2.02 OUTLET AND DEVICE BOXES

A. Outlet boxes for surface mounted and pendant mounted lighting fixtures shall be 4" octagon boxes, 1-1/2" deep.

B. Outlet boxes for flush mounted lighting fixtures shall be 4" square boxes 1-1/2" deep, with blank cover, installed adjacent to fixture. Connection to fixture shall be with flexible conduit and fixture wire.

C. Outlet boxes for switches, receptacles and wall mounted junction boxes shall be 4" square boxes, 1-1/2" deep with square edge tile type cover. Where only one conduit enters box, 3-1/2" deep single gang switch box may be used. Outlet boxes for GFI receptacles shall be 2-3/4" deep.

D. Outlet boxes for switches and receptacles in exposed wiring system shall be cast FS boxes with matching device plate. Device plates for exterior installations shall be spring loaded hinged covers. Use FD box for GFI receptacle.

E. Outlet boxes for individual switches, and receptacles flush mounted in exposed concrete block shall be single gang masonry boxes 3-1/2" deep.

F. Where special purpose device specified requires larger outlet box than specified herein, provide outlet box suitable for specific device. These outlet boxes shall be of the same type as specified herein for the installation required.

G. Outlet boxes installed in poured concrete or cast in place shall be concrete-tight type. The box depth shall allow 2" minimum of concrete cover.

2.03 JUNCTION AND PULL BOXES

A. Dimensions of pull boxes and junction boxes shall not be less than those dimensions required by the National Electrical Code for the number, size and position of conductors entering the box. Extension rings shall not be permitted on a box to increase the volume.

B. Pull boxes installed in finished spaces shall be flush mounted cabinets provided with trim, hinged door and flush latch and lock to match panel trim for flush mounted electrical panelboard.

C. Pull boxes required for horizontal feeders containing more than one feeder shall be provided with reinforced flange and removable 12 gauge 1-1/2" x 1-1/2" galvanized channel for support of conductors. Wood supports within pull boxes are not acceptable.

D. Provide box covers for all junction and pull boxes.

2.04 EXTERIOR JUNCTION OR PULL BOXES, FLUSH WITH GRADE

A. Junction or pull box to be mounted flush with grade shall be as indicated on the drawings. Provide polymer concrete, tier 22 traffic rated sized in accordance with the National Electrical Code minimum requirements. Covers shall be polymer concrete, tier 22 traffic rated with identifying system (i.e. Electrical) in cover secured to box with stainless steel bolts. Conduit entry shall be by field drilled openings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All boxes shall be completely accessible and as required by the NEC. Provide access panels in any non-accessible spaces to allow access to boxes installed. Crawling above ceilings to access boxes is not acceptable.

B. Provide an outlet box for each lighting fixture and for each device. Boxes shall not be smaller than indicated in this section of the specifications and shall be larger if required by Article 314 of the National Electrical Code for the number and size of conductors installed. Where lighting fixtures are installed in continuous rows, only one outlet box shall be required.

C. Outlet boxes for flush mounted lighting fixtures shall be accessible. Where fixture installation is in nonaccessible ceiling, outlet box shall be accessible when fixture is removed.

D. Set outlet boxes for flush mounted devices to within 1/8" of finished wall. Spacers or shims between box and device are not acceptable. Modification of boxes or use of extensioin rings to provide for 1/8” of finished wall is not acceptable.

E. Where low voltage device is to be installed in common outlet boxes with line voltage device, provide metal barrier within outlet box to establish two separate compartments.

F. Where drawings indicate ganged installations of switches controlling 277 volt lighting circuits of opposite phase, separate switches with permanently installed nonmetallic barrier. Where space available for horizontal ganged installation is not adequate, install switches vertically to maintain required clearances between energized terminals.

G. Support every box from structure:

1. Secure to wood with wood screws.
2. Secure to hollow masonry with toggle bolts.
3. Secure to metal with sheet metal screws, machine bolts, or clamps.
4. Anchors for solid masonry and concrete shall be self drilling expansion shields, insert expansion shields, or lead shields with machine bolts. Power actuated pin studs may be used in concrete.
5. Secure outlet boxes to metal studs with spring steel clamp which wraps around entire face of stud and digs into both sides of stud. Clamp shall be screwed into stud.
6. Where box is suspended below structure, support from structure with threaded steel rod. Secure rod directly to outlet boxes with double nuts. For pull boxes larger than 18" x 18" x 6", construct 1-1/2" x 1-1/2" x 14 gauge metal channel frame. Connect frame to box by bolting and secure frame to threaded rod at each corner.
7. Hub type cast boxes need not be directly attached to structure if rigid conduit is used and supported in conformance with the NEC.

H. Support outlet boxes for support of surface mounted incandescent lighting fixtures by light weight channel spanning between and attached to main ceiling support member. Attach channel to ceiling support members with galvanized tie wire or nylon tie straps.

I. Do not use outlet boxes for support of fluorescent fixtures; boxes shall be used only as junction boxes.

J. Remove only knockouts as required and plug all unused openings. Use threaded plugs for cast boxes and snap-in metal plugs for sheet metal boxes.

K. Outlet boxes in the same wall shall not be mounted back-to-back. Offset 6" minimum.

L. Install pull boxes only in unfinished spaces or concealed above ceilings, except when indicated on the drawings or approved by the Engineer.

M. Install pull boxes when any of the following conditions apply:

1. Where indicated on the drawings.
2. Where conduit run exceeds 200 ft. from box to box or box to terminal.
3. Where conduit contains more than 4-90 degree bends or the equivalent offsets.

4. To facilitate conductor installation or to insure that the manufacturer's maximum pulling tension is not exceeded.
5. As described in the RACEWAYS section of the specifications for crossing expansion joints.

N. Do not splice conductors in pull boxes. Splices are not permitted in pull boxes except when approved in writing by the Engineer or where shown on the drawings. Where splices are permitted, make splices with splicing sleeves attached to conductors with hydraulic crimping tool. Split bolt connectors are not acceptable for splices within pull boxes.

O. Where a pull box is required, one shall be installed for each individual branch circuit conduit or each feeder. It shall contain only the feeder conductors or those conductors in the conduit. A combined pull box for multiple branch conduits or feeders is not permitted, unless approved by the Engineer or indicated on the drawings. Where permitted for multiple circuits within pull box:

1. Circuit conductors and feeders shall be individually laced with nylon tie straps of the type with enlarged tab to permit identification of each circuit and feeder within pull box. Identify each with respect to load served.
2. Feeder circuits shall be wrapped, in accordance with manufacturer's recommendations, with arc-proof and fire proof tape.

P. Box covers shall be in place and secured to box.

Q. Identification

1. Refer to ELECTRICAL IDENTIFICATION section of these specifications for additional requirements.

R. Exterior pull or junction boxes

1. Exterior pull or junction boxes shall be mounted flush with the grade, unless specified elsewhere or indicated to be aboveground on the drawings.
2. Flush mounted boxes shall be surrounded on all sides and bottom with 6" minimum of concrete. Top of concrete shall be flush with grade.
3. Seal conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.
4. Taps and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean all work of dirt, paint and construction debris.

END OF SECTION

DIVISION 26 – ELECTRICAL

260533.02 – ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.

B. Applications of electrical power connections specified in this section include the following:

1. To resistive heaters.
2. From electrical source to motor starters.
3. From motor starters to motors.
4. To lighting fixtures.
5. To transformers and similar current current adjustment features of equipment.

C. Electrical connections for equipment, not furnished as integral part of equipment, are specified in Division - 15 and other Division - 16 sections, and are work of this section.

1. Division 1 - GENERAL REQUIREMENTS
2. Division 11 - EQUIPMENT
3. Division 13 - SPECIAL CONSTRUCTION

D. Motor starters and controllers, not furnished as integral part of equipment, are specified in applicable Division - 16 sections, and are work of this section.

E. Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Division - 16 sections, and are work of this section.

F. Raceways and wires/cables required for connecting motors and other electrical units of equipment are specified in applicable Division 16 sections, and are work of this section.

G. Electrical identification for wire/cable conductors is specified in Division - 16 section, ELECTRICAL IDENTIFICATION, and is work of this section.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with applicable requirements of NEC as to type products used and installation of electrical power connections (terminals and splices), for junction boxes, motor starters, and disconnect switches. NEC Article 110-14, "ELECTRICAL CONNECTIONS" applies to above.

B. IEEE Compliance: Comply with Std 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to connections and terminations.

C. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

1. ANSI/NEMA CC3: "Connectors for use between aluminum or aluminum-copper overhead conductors."
2. ANSI/EIA RS-364-21A: "Insulation Resistance Test"
3. STD SG-14: "Unplated split-bolt and Vice-Type Electrical Connectors for Copper Conductors".

D. UL Compliance: Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are UL-listed and labeled.

1. STD. NO. 486A; Wire Connectors and Soldering Lugs for Use with Copper Conductors.
2. STD. No. 486B; Wire Connectors for Use with Aluminum Conductors.
3. STD. NO. 486C; Splicing Wire Connectors.
4. STD. NO. 486D; Insulated Wire Connectors for Use With Underground Conductors.

E. ETL Compliance: Provide electrical connection products and materials which are ETL-listed and labeled.

F. ASTM Compliance: Comply with Standard B539 "Standard Methods for Measuring Contact Resistance of Electrical Connections (Static Contacts)."

G. Federal Specifications:

1. J-C-30 Electrical Cable and Wire (Power, Fixed Installation).
2. J-C-145 Electrical Power Cable and Electrical Wire (Weather Resistant).
3. W-C-596 1 through 212-Series. (Connectors).
4. W-S-610 Splice Conductor
5. HH-I-553 Electrical Insulation Tape (Rubber, Natural, and Synthetic).
6. HH-I-595 Electrical Plastic Insulation Tape, Pressure Sensitive Adhesive.

1.04 SUBMITTALS:

A. Product Data: Submit manufacturer's data on electrical connections for equipment products and materials.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver electrical connection products wrapped in proper factory-fabricated type containers.

B. Store electrical connection products in original cartons and protect from weather, construction traffic and debris.

C. Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of product):
1. AMP Incorporated.
2. Appleton Electric Company.
3. Arrow-Hart Div, Crouse-Hinds Company.
4. Bishop Div, General Signal Corporation.
5. Burndy Corporation.
6. General Electric Company.
7. Gould, Inc.
8. Harvey Hubbell Inc.
9. Ideal Industries, Inc.
10. Reliable Electric Company.
11. Square D Company
12. Thomas and Betts Corporation.

2.02 MATERIALS AND COMPONENTS

A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.

B. Metal Conduit, Tubing and Fittings:

1. Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Division - 16 BASIC ELECTRICAL MATERIALS and RACEWAYS section, and in accordance with the following listing of metal conduit, tubing and fittings:
   a. Rigid aluminum conduit.
   b. Rigid steel conduit.
   c. Rigid metal conduit fittings.
   d. Electrical metallic tubing.
   e. EMT fittings.
   f. Flexible metal conduit.
   g. Flexible metal conduit fittings.
   h. Liquid-tight flexible metal conduit.
   i. Liquid-tight flexible metal conduit fittings.

C. Wires, Cables, and Connectors:

1. Provide wires, cables, and connectors complying with Division - 16 basic electrical materials and methods section "WIRES AND CABLES".
2. Wires/Cables: Unless otherwise indicated, provided wires/cables (conductors) for electrical connections which match, including sizes and ratings, of wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals which are recommended by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL CONNECTIONS:

A. Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

D. Cover splices with electrical insulating material equivalent, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

E. Prepare cables and wires by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL 486A.

H. Provide PVC conduit and fittings as indicated for highly corrosive atmospheres.

I. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.

J. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subject to one or more of the following conditions:

1. Exterior location.
2. Moist or humid atmosphere where condensate can be expected to accumulate.
3. Corrosive atmosphere.
4. Water spray.
5. Dripping oil, grease, or water.

K. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division - 16 section ELECTRICAL IDENTIFICATION. Affix markers on each terminal conductor, as close as possible to the point of connection.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION

DIVISION 26 – ELECTRICAL

260553 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Extent of electrical identification work is as outlined by this specification.

B. Types of electrical identification work specified in this section include the following:

1. Buried cable warnings.
2. Electrical power, control and communication conductors.
3. Operational instructions and warnings.
4. Danger signs.
5. Equipment/system identification signs.

C. Refer to Division 1 General Requirements section IDENTIFICATION SYSTEMS, for equipment and system nameplates, and performance data; not work of this section.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

B. UL Compliance: Comply with applicable requirements of UL Std 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

C. ANSI Compliance: Comply with applicable requirements of ANSI Std A13.1, "Scheme for the Identification of Piping Systems".

D. NEMA Compliance: Comply with applicable requirements of NEMA Std No's WC-1 and WC-2 pertaining to identification of power and control conductors.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):

1. Almetek
2. Brady, W.H. Company
3. Calpico Inc.
4. Cole-Flex Corporation
5. Direct Safety Company
6. George-Ingraham Corporation
7. Griffolyn Company
8. Ideal Industries, Inc.
9. LEM Products, Inc.
10. Markal Company
11. National Band and Tag Company
12. Panduit Corporation
13. Seton Name Plate Company
14. Tesa Corporation

2.02 ELECTRICAL IDENTIFICATION MATERIALS

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

B. Color-Coded Plastic Tape:

1. Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1-1/2" wide.
   a. Colors: Unless otherwise indicated or required by governing regulations, provide orange tape.

C. Underground-Type Plastic Line Marker:

1. Manufacturer's standard permanent, detectable, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.

D. Cable/Conductor Identification Bands:

1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

E. Plasticized Tags:

1. Manufacturer's standard pre-printed or partially pre-printed accident-prevention and operational tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

F. Self-Adhesive Plastic Signs:

1. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.
2. Colors: Unless otherwise indicated, or required by governing regulations, provide white signs with black lettering.

G. Baked Enamel Danger Signs:

1. General: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20-gage steel; of standard red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.

H. Engraved Plastic-Laminate Signs:

1. Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
2. Thickness: 1/8", except as otherwise indicated.
3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.03 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC and OSHA.
2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Conduit Identification:

1. Where electrical conduit is exposed in spaces with exposed mechanical piping which is identified by color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise indicated, use white as coded color for conduit.

C. Box Identification:

1. After completion, using an indelible wide tip marker, indicate on the cover of each junction and pull box the designation of the circuits contained therein, i.e., A-1, 3, 5. Use a black marker for normal power circuits and a red marker for emergency circuits.

D. Underground Conduit Identification:

1. During back-filling/top-soiling of each exterior underground electrical, signal or communication conduit, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.
2. Install line marker for every buried conduit, regardless of whether direct-buried or protected in conduit.

E. Cable/Conductor Identification:

1. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work. Refer to WIRES AND CABLES section of these specifications for color coding requirements.

F. Operational Identification and Warnings:

1. Wherever required by OSHA or directed by the Owner, to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities equipment by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

G. Danger Signs:

1. In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work or the Owner as constituting similar dangers for persons in or about project.
   a. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.
   b. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.

H. Equipment/System Identification:

1. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/-control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated provide single line of text, 1/2" high lettering, on 1-1/2" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
   a. Panelboards, electrical cabinets and enclosures.
   b. Access panel/doors to electrical facilities.
   c. Major electrical switchgear.
   d. Motor control centers.
   e. Transformers.
   f. Power generating units.
   g. Automatic transfer switch.
2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate. Identification of flush mounted cabinets and panelboards shall be on the inside of the device.

3. Panelboards, individually mounted circuit breakers, and each feeder breaker in the distribution panels shall be identified with an engraved plastic laminate sign. Plastic nameplates shall be multicolored laminated plastic with faceplate and core as scheduled. Lettering shall be engraved minimum 1/4" high letters.
   a. 480/277 volt normal power equipment shall be identified with white faceplate with black core.
   b. 480/277 volt emergency power equipment shall be identified with white faceplate with red core.
   c. 208/120 volt essential power equipment shall be identified with red faceplate with white core.
   d. Equipment identification is to indicate the following:
      1) Equipment ID abbreviation.
      2) Voltage, phase, wires and frequency.
      3) Emergency or other system.
      4) Power source origination. Example:
         a) Panel E3HA
         b) 480/277V, 3 phase, 4 wire
         c) Emergency System
         d) Fed by SWBD-7

END OF SECTION

DIVISION 26 – ELECTRICAL

260573 – SHORT-CIRCUIT COORDINATION STUDY/ARC FLASH

PART 1 - GENERAL

1.01 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies which shall be prepared by the equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

1.02 RELATED SECTIONS

1.03 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories
5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

C. The National Fire Protection Association (NFPA)

1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace
3. submittals for review/approval

D. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.04 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies, where required, shall be provided on CD in PDF format.

B. The report shall include the following sections:

1. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
5. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
6. Incident energy and flash protection boundary calculations
7. Comments and recommendations for system improvements, where needed
8. Executive Summary including source of information and assumptions made

1.05 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical Engineer shall be a full-time employee of the Engineering Services Organization.

PART 2 - PRODUCT

2.01 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer. By using the equipment manufacturer the study allows coordination of proper breakers, fuses, and current transformers. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the 480 Volt motor control centers and power distribution panelboards. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.02 DATA COLLECTION

A. Contractor shall furnish all field data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future utility supplies, motors, and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.

D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.03 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.

B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Typical calculations
6. Tabulations of calculated quantities
7. Results, conclusions, and recommendations

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility’s supply termination point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses
3. Adequacy of transformer windings to withstand short-circuit stresses
4. Cable and busway sizes for ability to withstand short-circuit heating

5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

2.04 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:

1. Electric utility's protective device
2. Medium voltage equipment relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points
9. Pertinent generator short-circuit decrement curve and generator damage point
10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.05 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all 480V locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.06 REPORT SECTIONS

A. Input Data:

1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
2. Short-circuit reactance of rotating machines with associated X/R ratios
3. Cable type, construction, size, # per phase, length, impedance and conduit type
4. Bus duct type, size, length, and impedance
5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
6. Reactor inductance and continuous ampere rating
7. Aerial line type, construction, conductor spacing, size, # per phase, and length

B. Short-Circuit Data:

1. Source fault impedance and generator contributions
2. X to R ratios
3. Asymmetry factors
4. Motor contributions
5. Short circuit kVA

6. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:
   a. Current transformer ratio.
   b. Current setting.
   c. Time setting.
   d. Instantaneous setting.
   e. Specialty non-overcurrent device settings.
   f. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
   a. Adjustable pickups and time delays (long time, short time, ground).
   b. Adjustable time-current characteristic.
   c. Adjustable instantaneous pickup.
   d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude
2. Device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.01 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a 2-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

3.02 ARC FLASH WARNING LABELS

A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following information:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date

C. Labels shall be machine printed, with no field markings

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided
2. For each motor control center, one arc flash label shall be provided
3. For each low voltage switchboard, one arc flash label shall be provided
4. For each switchgear, one flash label shall be provided
5. For medium voltage switches one arc flash label shall be provided

E. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.03 ARC FLASH TRAINING

A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals.

END OF SECTION

DIVISION 26 – ELECTRICAL

262200 – TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of the furnishing, connection and installation of dry type transformers.

B. Definition: Dry type transformers, as described herein, applies to those with primary and secondary voltage connections of 600 volts and less. Autotransformers are not acceptable, except where indicated for buck boost or zig-zag connections.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standards: The following specifications and standards are incorporated into and become a part of this specification by reference.

1. Underwriter's Laboratories, Inc. (UL) Publications:
   a. No. 506 Transformers (1000 KVA, 3 phase and below; 167 KVA, 1 phase and below)
2. National Fire Protection Association (NFPA):
   a. No. 70 National Electrical Code (NEC)
3. National Electrical Manufacturers Association (NEMA):
   a. No. ST-20 Dry-type transformers for general applications
4. American National Standards Institute (ANSI):
   a. No. C57.12.80 Terminology for Power and Distribution Transformers
   b. No. C57.12.90 Guide for Short Circuit Testing of Distribution and Power Transformers
   c. No. C57.94 Recommended Practice for Installation, Application, Operation and Maintenance of Dry-Type General Purpose Distribution and Power Transformers

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. Eaton
2. General Electric
3. Square D

C. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure transformer access and clearance minimums are provided, and adequate ventilation is permitted.

1.04 SUBMITTALS

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section for submittal requirements.

B. Manufacturers Product Data:

1. Submit material specifications and installation data for products specified under PART 2 - PRODUCTS. Product data shall indicate sound and temperature rating, overload capacity and efficiency at 25%, 50% and 100% load, available taps, voltage, impedance, nameplate data, wiring diagrams, physical dimensions and net weight. Product data shall also contain certification that transformers are constructed and tested in accordance with standards specified herein.

C. Record Drawings. Include in each set:

1. A complete set of manufacturers product data indicating all post bid revisions and field changes.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein and indicated on the drawings.

B. All transformers shall be UL listed and bear a UL label.

C. Transformers shall be self-cooled, rated for continuous operation at rated KVA, 24 hours per day, 365 days per year with normal life expectancy (IEEE Standard No. 65). KVA ratings shall be as indicated on the drawings.

2.02 GENERAL PURPOSE DRY TYPE TRANSFORMERS

A. Insulation System

1. Single phase 25 - 167 KVA and three phase 30 - 1500 KVA: Transformers shall be rated for average temperature rise by resistance of 150°C. in 40°C. maximum ambient, 30°C average ambient. Transformer insulation system shall be UL rated as 220°C. system.
2. Three phase 3 - 15 KVA: Transformers shall be rated for average temperature rise by resistance of 115°C. Insulation system shall be 180°C.

3. Single phase up through 250 VA: Transformers shall be rated for 55°C. rise by resistance. Insulation system shall be 105°C.
4. Single phase 500 - 3000 VA: Transformers shall be rated for 115°C. temperature rise by resistance. Insulation system shall be 180°C.

B. Sound rating shall not exceed NEMA and ANSI standards for KVA rating. Internal vibration dampening shall be provided as a standard feature of all transformers.

C. Single phase transformers rated up to 15 KVA shall have two, 5 percent full capacity taps below normal rated primary voltage. All other single phase and all three phase transformers shall be provided with six 2-1/2% full capacity taps, two above and four below normal voltage unless only four 2-1/2% taps, two above and two below normal voltage, are standard.

D. Construction and Enclosures

1. Transformers 30 - 1500 KVA: Transformer enclosures shall be open, ventilated, drip-proof with removable front and rear cover panels. Transformers shall be suitable for floor mounting, unless wall mounting is indicated on the drawings.
2. Transformers up through 25 KVA: Transformers shall be totally enclosed, non-ventilated with a resin encapsulated core and coil and drip-proof housing. Removable panel section shall permit access to wiring compartment.

E. Dry type transformers shall provide 3 phase 4 wire 208Y/120 or 1 phase 3 wire 230/115 volt service, as indicated on the drawings, to designated panelboards or other equipment. Primary rating shall be 480 volts.

F. Nominal transformer impedance shall be 4.5 percent minimum, unless otherwise indicated on the drawings.

G. Dry type transformer K-factors shall be as indicated on the drawings and as outlined in ANSI C57.110 "Recommended Practice for Establishing Transformer Capability when Supplying Nonsinusoidal Load Currents."

H. Core assemblies and the center ground connection point of the coil secondaries shall be grounded to their enclosures by adequate, flexible ground straps. Provide grounding lug at the strap to enclosure bonding location for connection of three conductors; the primary and secondary equipment grounding conductors and the grounding electrode conductor.

I. Provide weather shield on transformers indicated on drawings and for all exterior installations.

2.03 BUCK-BOOST TRANSFORMERS

A. Buck-boost transformers shall comply with the requirements of General Purpose Dry Type Transformers, and have the additional features specified herein.

B. Buck-boost transformers shall be connected to provide the voltage modification indicated. Transformers shall be single phase, two winding, dry type transformers, UL listed and labeled as suitable for connection as autotransformer for buck-boost applications. KVA rating shall be for load to be served with autotransformer connections.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Dry transformers larger than 15 KVA shall be floor mounted, unless wall or suspension mounting is indicated on the drawings. Transformers 15 KVA and smaller shall be wall mounted. Installation shall provide not less than twelve inch clearance from walls or equipment. Floor mounted transformers shall be mounted on neoprene, waffle type vibration pads 5/8" thick. Where transformers are indicated on the drawings, or specified herein to be mounted on suspended channels of angles or wall mounted, transformers shall be bolted to structure with 5/8" thick vibration pad between transformer base and structural surface. Loosen shipping bolts to free up internal vibration mounts on core and coil assembly.

B. Primary and secondary connections to dry type transformers shall be made with flexible conduit.

C. The secondary windings of each dry type transformer shall be grounded in accordance with the National Electrical Code requirements for separately derived electrical systems. Extend a grounding electrode conductor from the transformer grounding lug to the nearest building structural steel or main column rebar. Connect the primary and secondary feeder equipment grounding conductors to the grounding lug. Refer to the secondary grounding section of these specifications for additional requirements.

D. Install secondary overcurrent protective device within 10 feet of conductor length. Where none is indicated on plans, provide enclosed circuit breaker within 10 feet rated at 125 percent of the transformer full load ampacity but not greater than the secondary conductor ampacity.

E. Do not install equipment over transformer, unless indicated on the drawings.

F. Locate transformers to provide working clearance and full accessibility as required by the National Electrical Code.

G. For the installation of buck-boost transformers, where three phase load is to be served, three single phase transformers are required. Provide 4" x 4" x 24" wiring trough with hinged cover for both primary and secondary interconnections. Connection to wiring trough from transformer shall be with flexible conduit.

3.02 CLEANING AND ADJUSTMENT

A. Prior to final inspection, under maximum available load, measure secondary voltage and adjust tap setting to deliver nominal rated voltage within the percentage limits of one tap setting. Record the voltages of each transformer and submit in accordance with the requirements specified in the basic electrical requirements section.

B. After completion, clean the interior and exterior of dirt, paint and construction debris.

C. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

3.03 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3.04 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

END OF SECTION

DIVISION 26 – ELECTRICAL

262413.01 – SWITCHBOARDS – FRONT ACCESSIBLE GROUP MOUNTED FEEDER DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the Specifications consists of the installation of all switchboards [designated on the drawings to have group mounted feeder devices with front access only construction] for use on systems 600 volts and below. All materials and devices which are an integral part of the switchboard shall be provided under this section of the specifications.

B. Definition: Switchboards are floor mounted assemblies of one or more enclosed vertical section containing circuit breakers, switches, meters, fuses, and terminals essential to operation of electrical equipment. A dead front switchboard has no exposed live parts on front.

1.03 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. National Electrical Manufacturers Association (NEMA) Standards:
   a. PB-2: Dead Front Distribution Switchboards
   b. PB-2.1: General Instruction for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards rated 600 volts or less.
   c. SG-3: Low Voltage Power Circuit Breakers.
2. Underwriters Laboratories, Inc. (UL):
   a. UL-489: Molded Case Circuit Breakers and Circuit Breaker Enclosures
   b. UL-891: Deadfront Electrical Switchboards
   c. UL-977: Fused Power Circuit Devices
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. STD-241: IEEE Recommended Practices for Electric Power Systems in Commercial Buildings
4. National Fire Protection Association (NFPA):
   a. NFPA-70: The National Electrical Code

5. American National Standards Institute (ANSI):
   a. C37.13: Low-Voltage AC Power Circuit Breakers used in Enclosures
   b. C37.16: Related Requirements and Application Recommendations for Low-Voltage Power Circuit Breakers and AC Power Protectors, Preferred Ratings

B. Equipment Dimensions

1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where switchboards of acceptable manufacturers listed exceed the maximum dimensions, products of such manufacturers shall not be acceptable.

C. Coordination

1. Review shop drawings submitted under this and other sections, as well as other divisions, to ensure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with engineering and structural features, equipment installed under other sections of the specifications and electrical equipment to insure access and so that clearance minimums are provided.

1.04 SUBMITTALS

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section for submittal requirements.

B. Product Data: Switchboards including, but not limited to, voltages, number of phases, frequencies, and short-circuit and continuous current ratings. Provide application data for main and branch circuit-breakers, sections, main buses, and basic insulation levels.

C. Shop Drawings: Layout drawings of switchboards showing accurately scaled basic equipment sections including auxiliary compartments, section components, and combination sections.

D. Wiring Diagrams: For switchboards showing connections to electrical power feeders and distribution branches. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.

E. Closeout Submittals: As follows:

1. Record Drawings: Include in each set:

F.

1. Complete set of switchboard manufacturers' product data and shop drawings indicating all post bid revisions and field changes.
2. Schedule of each overcurrent protection device indicating unit ampere rating and trip rating.

3. Copy of the ground-fault system performance test as required by Article 230-95(c) of the NEC.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Deliver switchboards and components properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for switchboards and components which protect equipment from damage. Install gravity measuring meters in containers which indicate whether container has been bumped or dropped. Return G-meters to manufacturer for re-use upon delivery of switchboards. Inspect equipment to ensure that no damage has occurred during shipment.

B. Store switchboard equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle switchboard equipment carefully to prevent physical damage to equipment and components. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which would damage the electrical equipment contained therein. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.06 SEQUENCING AND SCHEDULING

A. Schedule delivery of switchboard equipment which permits ready building ingress for large equipment components to their designated installation spaces. Coordinate delivery of equipment with the installation of other building components.

B. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.

C. Coordinate with other electrical work including raceways, electrical boxes and fittings, and cabling/wiring work, as necessary to interface installation of switchboards with other work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton
2. General Electric
3. Square D

2.02 GENERAL

A. AC Dead-Front Distribution Switchboards: Provide factory-assembled, dead-front, metal-enclosed, self-supporting secondary power switchboards, of types, sizes, electrical ratings and characteristics indicated; consisting of vertical panel units, and containing circuit-breakers of quantities, ratings and types indicated. Provide copper main bus and connections to circuit-breaker branches of sufficient capacity to limit rated continuous current operating temperature rise of no greater than 65°C above average ambient temperature of 25°C; with main bus and tap connections silver-surfaced and bolted tightly according to manufacturer's torquing requirements for maximum conductivity. Brace bus for short-circuit stresses up to maximum interrupting capacity. Provide accessibility of line and load terminations from front of switchboard. Equip units with built-in lifting eyes and yokes; and provide vertical individual panel units, suitable for bolting together at project site. Construct switchboard units for the following environment:

1. Installation: Indoors, NEMA Type 1.

B. Provide accessory and instrumentation small wiring, necessary fuse blocks and terminal blocks within the switchboard. Control components, such as control transformers, fuse blocks, relays, etc., shall be suitably marked for identification where mounted on the switchboard corresponding to appropriate designations on manufacturer's wiring diagrams. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

2.03 BUSSING

A. All bus bars shall be silver-plated copper with bolted connections at joints. The bus bars shall be of sufficient size to limit the temperature rise to 65°C rise based on UL tests, and rated to withstand mechanical forces exerted during short circuit conditions when directly connected to a power source having an available fault current as shown on the drawings. Provide full capacity neutral where a neutral is indicated on the drawings.

B. A ground bus rated a minimum of 25% of main bus ampacity shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard. An incoming ground lug shall be furnished. Other ground lugs for feeder circuits shall also be supplied as shown in the schedules on the drawings.

C. All hardware used on conductors shall be high-tensile strength and plated. All terminals shall be of the anti-turn solderless type suitable for CU or A1 cable of sizes indicated for 75°C cable.

2.04 CONSTRUCTION

A. Switchboards shown mounted against a wall shall be front accessible. All sections of the switchboard shall be 20" deep except service sections containing large ampacity main disconnects which may be deeper as required. All sections of the switchboard shall align so that the back of the complete structure may be placed flush against a wall.

B. Construction shall allow maintenance of incoming line terminations, main device connections and all main bus bolted connections to be performed without rear access. The feeder or branch devices shall be removable from the front and shall be panel mounted with the necessary device line and load connections front accessible. Provide lugs on all devices for cable sizes shown on drawings.

2.05 METERING

A. Where indicated on the drawings, provide a separate customer metering compartment with front hinged door and include the following:

1. Current transformers
2. Potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.
3. Indicating ammeter with ammeter switch indicating voltmeter with voltmeter switch and KWHR demand meter.

2.06 OVERCURRENT DEVICES - GENERAL

A. Main protective devices shall be fixed mounted molded case breaker with interrupting rating, frame and trip ratings as shown on the drawings.

B. Group mounted feeder protective devices shall be molded case breaker type with frame and trip rating as shown on the drawings and have additional characteristics as specified.

C. Devices shall be manually operated (MO) unless electrically operated (EO) is indicated on the drawings.

2.07 MOLDED CASE BREAKERS

A. Protective devices as shown shall be molded case circuit breakers providing complete circuit overcurrent protection by having inverse time and instantaneous tripping characteristics, and where applicable, be current limiting.

1. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip free. Automatic tripping of the breaker shall be clearly indicated by handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes.

2. Circuit breaker interrupting capacities shall be as indicated on the drawings or as specified hereinafter. Where applicable, circuit breakers shall be listed for series application.

B. Breakers 150 ampere and below shall be thermal-magnetic trip with inverse time current characteristics. Breakers with 250 and 400 ampere frame shall be thermal-magnetic or solid-state trip, as applicable.

C. Breakers with 600 amperes frame and above shall be solid-state trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip. Breakers shall have trip rating plugs with ratings as indicated on the drawings. Rating plugs shall be interlocked so they are NOT interchangeable between frames and interlocked such that a breaker cannot be latched with the rating plug removed.

1. Trip units shall have adjustable short time setting with a fixed instantaneous override for circuit protection. Main breakers shall be provided with additional instantaneous and short delay trip time adjustment for increased system coordination.
2. Breakers shall have built-in test points for testing long delay, instantaneous and ground fault functions of the breaker by means of a 120 volt operated test kit. Provide one test kit capable of testing all breakers 600 ampere and above.
3. Where indicated on the drawings, provide built-in ground fault protection with adjustable pick-up rating not exceeding 1200 amperes; ground fault time delay shall be adjustable 0.1 to 0.5 seconds. Provide neutral ground fault current transformer for four wire systems.

D. Where indicated on the drawings, provide zero sequence ground fault protection system with necessary sensor, monitor, test panel, shunt trip and control power source for use with breakers indicated.

2.08 NAMEPLATES

A. Engraved nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments. Nameplates shall give item designation and circuit number as well as frame size and appropriate trip rating. Furnish Master nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number. Refer to ELECTRICAL IDENTIFICATION section of this specification.

2.09 FINISH

A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 and use the manufacturer's standard process.

2.10 CONTROL POWER TRANSFORMERS

A. Control power transformers with primary and secondary protection shall be provided as indicated on the drawings or where required to operate ground fault systems, adequately sized for required burdens.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions under which switchboards and components are to be installed, and notify General Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF SWITCHBOARDS:

A. Install switchboards as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices; complying with applicable requirements of NEC, NEMA's Stds Pub/No. PB 2.1, and NECA's "Standard of Installation".

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486 A and B, and the National Electrical Code.

3.03 FIELD QUALITY CONTROL

A. Refer to ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

3.04 ADJUSTING AND CLEANING

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finishes.

3.05 GROUNDING

A. Provide equipment grounding connections for switchboards as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.06 FIELD QUALITY CONTROL

A. Subsequent to wire and cable hook-ups, energize switchboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

DIVISION 26 – ELECTRICAL

262416 – PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work required under this section of the specifications consists of the furnishing, installation and connection of lighting and appliance panelboards and distribution type panelboards.

B. Panelboards designated as HDA, HDB, DA, DB, etc., or indicated on the drawings shall be distribution type panelboards. Those designated as HA, HB, A, B, etc., are lighting and appliance type panelboards.

C. Definitions: The term panelboard, as used in this specification or on the drawings, shall mean the complete assembly including the enclosure, bus work, trim hardware and circuit breaker or fused devices. The words panel and panelboard are used synonymously in these contract documents.

1.03 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 50: Cabinets and Boxes, Electrical
   b. No. 67: Panelboards
   c. No. 489: Molded Case Circuit Breakers and Circuit Breaker Enclosure
2. Federal Specifications (Fed Spec):
   a. WC-375: Circuit Breakers
3. National Electrical Manufacturer's Association (NEMA) Publications:
   a. No. PB-1: Panelboards
   b. No. AB-3: Molded Case Circuit Breakers
4. National Fire Protection Association (NFPA):
   a. No. 70: National Electrical Code (NEC)

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. General Electric
2. Eaton
3. Square D

C. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure panel access and insure that clearance minimums are provided.

1.04 SUBMITTALS

A. Refer to BASIC ELECTRICAL REQUIREMENTS for submittal requirements.

B. Manufacturers Product Data:

1. Submit material specifications and installation data for products specified under Part 2 - Products to include:
   a. Circuit breakers
   b. Panelboards

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings.

1. Include electrical characteristics and ratings for each panelboard with dimensions, mounting, bus material, voltage, ampere rating, mains, poles and wire connection, and any accessories. Indicate method of ground bus attachment to enclosure.
2. Include front elevation bussing diagram indicating each bussing circuit breaker position.
3. Provide a schedule indicating circuit breaker type, trip and size, poles, frame type, and interrupting capacity.

D. Record Drawings. Include in each set:

1. A complete set of panelboard manufacturers product data and shop drawings indicating all post bid revisions and field changes.
2. A copy of each panelboard directory incorporating all post bid revisions and field changes.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All panels and circuit breakers shall be UL listed and bear a UL label.

C. Panels shall be of the dead front safety type.

D. Provide panels complete with factory assembled circuit breakers connected to the bus bars in the positions shown on the panel schedules or bus diagrams as indicated on the drawings.

E. Number all panelboard circuits in the following sequence:

1. Circuits No. 1 and 2, Phase A; Circuits No. 3 and 4, Phase B; Circuits No. 5 and 6, Phase C. Connect two pole breakers to phase indicated on the drawings.

2.02 BUSSING AND INTERIORS

A. All bus bars shall be copper. Main lugs and main breakers shall be UL approved for copper or aluminum conductors and shall be of a size range for the conductors indicated on the drawings. Each panel shall contain an equipment grounding bus. Each lighting and appliance panelboard shall contain a full size insulated neutral bus. Where a distribution type panelboard is indicated on the drawings to have a neutral bus, the bus shall be insulated and full size, unless otherwise indicated on the drawings.

B. The neutral and ground busses shall have a sufficient number of lugs to singularly terminate each individual conductor requiring a connection.

C. The ground bus shall be factory brazed, riveted or installed on studs bolted to the panel enclosure or panel frame. The ground bus shall not be attached to the panel interior.

D. Where designated on panel schedule as "space", include all necessary bussing, device support and connections. Provide blank cover for each space.

2.03 ENCLOSURES

A. Panelboard width shall not be less than 20", nor more than 22" unless specific width is indicated on the drawings. Panelboard depth shall not exceed 5-3/4".

B. Distribution panelboard width shall not be less than 31" and the depth shall not exceed 14".

C. Review panelboard schedules and system one line diagram and provide panelboard gutters and bending space at terminals to conform to the National Electrical Code.

D. Provide concealed captive clamping devices, concealed hinges and lock for all flush mounted panels. Key all panels throughout project alike.

E. All surface mounted panels shall be provided with door-in-door hinged cover trims. Trims shall be secured by piano hinges to enclosure and secured closed by two trim clamps.

F. Provide a directory card, metal holder, and transparent cover permanently mounted on inside of doors.

G. Where indicated on the drawings or required for the environmental conditions, provide a NEMA 12 enclosure.

2.04 CIRCUIT BREAKERS

A. Interrupting rating of all circuit breakers in panelboards operating on 208Y/120 volt system shall have UL rating of not less than 10,000 RMS symmetrical amps at system voltage. Panelboards for use on 480Y/277 volt system shall contain circuit breakers with UL interrupting rating of not less than 14,000 RMS symmetrical amps at system voltage. Provide circuit breakers with higher interrupting capacity when indicated on the drawings.

B. Circuit breakers shall be provided with trip rating, poles and minimum interrupting rating as indicated on the drawings or specified herein.

C. Multi-pole breakers shall be common trip and common reset; tie handle connection between single pole breakers is not acceptable.

D. Branch circuit breakers in lighting and appliance panels shall be quick-make, quick-break, thermal magnetic type bolted to the bus. Circuit breakers in distribution type panelboards shall be bolted to the bus except, Square D I-line style plug in devices are acceptable.

E. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 ampere frame or less. Magnetic trip shall be adjustable for breakers with 600 ampere frames and higher. Factory setting shall be HI, unless otherwise noted.

F. Provide the following special devices and accessories when indicated on the drawings, specified herein, or required by the NEC.

1. Ground fault interrupting circuit breaker (GFI).
2. Provide handle lock-off device to prevent manually turning off device without removal. Install on all circuit breakers indicated on the panel schedule.

2.05 SEPARATELY ENCLOSED MOLDED CASE CIRCUIT BREAKERS

A. Where separately enclosed molded case circuit breakers are shown on the drawings, provide circuit breakers in accordance with the applicable requirements of those specified for panelboards.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount panelboards with top circuit not more than 6'-6" above finished floor.

B. Lace and group conductors installed in panels with nylon tie straps. Only one conductor shall be installed under terminal of individual circuit breakers. Form and train conductors in panel enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eights inch from terminal lug.

C. Do not splice conductors in panels. Where required, install junction box adjacent to panel and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the conductors and cables section of the specifications and do not exceed.

D. Mounting and Support

1. Mounting
   a. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. A 1.5" minimum diameter round washer shall be used between head of screw or bolt and enclosure.
   b. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
   c. Attach enclosure directly to masonry, concrete, or wood surfaces.
   d. Mount enclosure on metal channel (strut), which is connected to structure with fastening device specified, for installations on steel structure or sheet rock walls.

E. Conductors not terminating in panelboard shall not extend through or enter panel enclosure.

F. Maintain conductor phase color code requirement described in the wires and cables section of the specifications.

G. Provide in each panelboard with a typewritten circuit directory mounted under clear plastic in a metal directory frame on interior of panel door. Directory shall reflect any field changes or additions.

H. Install push-in knock-out closure plugs in any unused knock-out openings.

I. Identification

1. Panelboards and individually mounted circuit breakers shall be identified.
2. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3. Submit complete schedule with the shop drawings listing all nameplates and information contained thereon.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

C. Adjust and align panelboard interior and trim in accordance with manufacturers recommendations, and to eliminate gaps between the two.

3.03 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

END OF SECTION

DIVISION 26 – ELECTRICAL

262419 – MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.02 SUMMARY

A. The work required under this section of the Specifications consists of the installation of all Motor Control Centers for use on systems 600 volts and below. All materials and devices which are an integral part of the Motor Control Center shall be provided under this section of the specifications.

B. Definition: Motor Control Centers are floor mounted assemblies of one or more enclosed vertical sections having a common horizontal power bus and primarily containing combination Motor Control Units. Units are mounted one above the other in the vertical sections, with power supplied to the individual units by vertical power busses. The words motor control units, starters, and motor controllers are used synonomously in these contract documents.

1.03 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. National Electrical Manufacturers Association (NEMA) Standards:
   a. ICS-1: General Standards for Industrial Control and Systems
   b. ICS-2: Industrial Control Devices, Controllers and Assemblies
   c. ICS-3: Industrial Systems
   d. ICS-4: Terminal Blocks for Industrial Control Equipment and Systems
   e. ICS-6: Enclosures for Industrial Controls and Systems
2. Underwriters Laboratories, Inc. (UL) Publications:
   a. UL 198.4: Class R Fuses
   b. UL 508: Industrial Control Equipment
   c. UL 845: Standard for Motor Control Centers
3. National Fire Protection Association (NFPA)
   a. NFPA 70: National Electrical Code
4. American National Standards Institute (ANSI):
   a. C97.1: Low Voltage Cartridge Fuses, 600 Volts or Less

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. Motor control centers and controllers:
   a. Square D
   b. General Electric
   c. Eaton
2. Fuses:
   a. Gould-Shawmut
   b. Buss
   c. Littlefuse

C. Equipment Dimensions

1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where motor control centers of acceptable manufacturers listed exceed the maximum dimensions, products of such manufacturers shall not be acceptable.

D. Coordination

1. Review shop drawings submitted under this and other sections, as well as other divisions, to ensure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure access and so that clearance minimums are provided.

1.04 SUBMITTALS

A. Refer to basic electrical requirements section for submittal requirements.

B. Manufacturer's Product Data:

1. Submit material specifications and installation data for products specified under Part 2 - Products to include:
   a. Motor controllers
   b. Motor control centers
   c. Fuses

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings.

1. Include electrical characteristics and ratings for each motor control center with dimensions, mounting, bus material, voltage, bracing, ampere rating, mains, poles and wire connection, and any accessories.
2. Include bussing diagram indicating each bussing motor control unit, circuit breaker, or fused switch position.

3. Provide a schedule indicating motor control unit type, or trip and size, poles, frame type, fuse size and type, and interrupting capacity.
4. Identification designation schedule.

D. Record Drawings - Include in each set:

1. A complete set of motor control center manufacturers product data and shop drawings indicating all post bid revisions and field changes.
2. A schedule of each motor's actual full load nameplate rating and NEMA design with the selected overload heater catalog number and current range.

PART 2 - PRODUCTS

2.01 GENERAL

A. Furnish all materials specified herein.

B. Motor control center, motor control units, circuit breakers, and fused devices shall be UL listed and bear the UL label.

C. The type of enclosure shall be in accordance with NEMA standards for Type 1, gasketed construction. All enclosing sheet steel, wireways and unit doors shall be gasketed.

D. The motor control center shall be suitable for operation on a 277/480 3-phase, 4-wire 60 Hz system.

E. Motor control center wiring shall be NEMA Class I type B.

2.02 STRUCTURE ARRANGEMENT

A. Motor Control Center shall consist of free-standing, standardized vertical sections; each section shall have the following nominal dimensions: 90" H. x 20" W. x 16D. Maximum overall dimensions, not to be exceeded, shall be as indicated on the drawings.

B. Each section shall contain continuous horizontal and vertical wireways. The horizontal wireway shall be located at the top and bottom of the section. Vertical wireways shall be provided adjacent to each unit. All wireways shall have provisions for cable support, shall be isolated from the bus bars and shall be accessible through hinged doors held closed by captive screws.

C. Adequate space for conduit and conductors entering the top or bottom, in accordance with the National Electrical Code, shall be provided without structural interference. Conductors shall be safely accessible without disrupting service.

D. Individual sections shall be assembled to form a totally enclosed deadfront, front accessible motor control center, as indicated on the drawings.

E. Motor control center design shall permit the future installation of matching vertical sections without the need for transition sections.

2.03 BUS ARRANGEMENT

A. Each vertical section shall contain a continuous three-phase bus, rated as shown on the drawings. Vertical busses shall be connected to the main horizontal bus.

B. A continuous, three-phase, main horizontal bus, rated as shown on the drawings, shall be provided for the distribution of power to the vertical busses. The main bus shall be located in the upper part of the structure.

C. Each vertical section shall contain a neutral bus connected to a main horizontal neutral bus, all rated at 50% of the main bus rating.

D. All non-current-carrying parts of the control center shall be grounded through the use of a continuous horizontal ground bus connected to vertical ground busses in each section. Ground bus rating shall not be less than 25% of main bus rating. Bus design shall include feature that for any plug-on unit the ground bus stab shall make contact with the ground bus before the power bus contact is made.

E. All busses shall be tin-plated copper, rated for a 50 degrees C. temperature rise above a 40 degrees C ambient. The minimum bus bracing, in RMS - symmetrical-amperes, shall be as shown on the drawings. Busbars shall be isolated and insulated with polyester boards front and back.

F. A front accessible main lug compartment shall be provided for incoming line termination. Lugs shall be suitable for terminating the size and quantity of conductors as indicated. The compartment shall be located in the unit space shown on the drawings and shall have a hinged door held closed by captive screws. Door shall have provisions for a padlock.

2.04 UNIT CONSTRUCTION

A. Combination magnetic starters shall be installed in removable units constructed in basic heights of 12" or multiples thereof. Each unit shall be isolated from others on structure. Connection to vertical bus for NEMA size five across the line starters and smaller shall be made with draw out stab type connection. Each plug-in type unit shall have a provision for positive horizontal and vertical alignment. Provisions shall also be included for positive ground connections through plug-in facilities. Each magnetic starter shall contain a solid state overload relay in each phase. Each unit shall contain separable control terminal blocks and separable power terminal blocks to permit removal of unit without disturbing control wiring.

B. Magnetic starters shall be the combination type with molded case circuit breakers. UL listed interrupting rating of molded case circuit breakershall not be less than indicated on the drawings at system voltage.

C. Reduced voltage magnetic starters shall be combination, closed transition, solid state type.

D. Individual starter doors and individual overcurrent device doors shall be interlocked to prevent door from being opened until switch is in "OFF" position. However, a "cheater screw" or other inconspicuous means shall be provided to permit access to energized starter, by authorized personnel. An interlock contact shall be provided within the starter to open control circuit to magnetic starter when device handle is in the open position. A door activated interlock switch is not acceptable.

E. Each starter shall be provided with HOA switch, as indicated on the drawings. Where no device is indicated on the drawings, provide an HOA switch for any motors automatically controlled or an ON-OFF switch for those specified to be manually controlled. Provide each magnetic starter with a "RUN" and an "OVERLOAD" pilot lamp. Control devices shall be of oil tight construction and shall be mounted on a removable panel on the unit door. Identify each control device with a metal tag or plastic laminated label.

F. Overload protection shall be adjustable and manually reset solid state type shall be selected in accordance with full load rating of motors actually furnished. Relay switching mechanism shall be single pole, double throw with normally open position connected to operate a door mounted, oil tight blue pilot lamp to indicate starter has tripped on overload.

G. Control voltage for magnetic starters shall be 120 volts obtained from a individual control power transformers in each starter. Each control power transformer shall be fused.

H. Provide contacts in magnetic starters to provide interlocking control sequence of operation specified under Division 15. Provide one normally open and one normally closed spare auxiliary contact in each starter.

I. Starter sizes are based on design conditions using horsepower ratings of motors indicated on drawings. If motors actually furnished have horsepower ratings other than those indicated, motor starters and feeders shall be adjusted in accordance with the rated horsepower at no additional cost to the Owner.

J. Provide, where indicated, molded case circuit breakers for feeder protection. All circuit breakers shall have UL interrupting rating of not less indicated on the drawings, at system voltage.